The Dock and Harbour Authority

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Editorial Comments

New Volume.

'th this number is commenced a new volume: the XXVth quence; and an occasion of this kind seems to demand, at rate, a passing comment, especially at a juncture when after olonged period of incessant hostilities, great hopes and high ctations are entertained of an early termination of the War its bitter and shattering experiences. Unfortunately, it to be admitted that these hopes and expectations have been tained before; indeed, in each of the last three or four s, and they have all been frustrated by the unforeseen trend vents. Truly, "hope deferred maketh the heart faint," despite a much brighter outlook than ever before, we must ndulge in unduly optimistic anticipations. That a successissue for the Allied Forces is bound to come eventually, the try firmly and justifiably believes, but it would be idle to t on any immediate realisation of the national hope, though possible that such a consummation may come sooner than y people imagine.

s regards the position of this Journal and its prospects for future, our readers cannot fail to realise the difficulties under ch its editorial conduct is labouring, and we desire to express grateful appreciation of the kindness and forbearance nded to the Journal under the depressing circumstances in ch it is placed. Serious depletion of staff, a rigorous cenship, vetoing much serviceable matter, and strict rationing of erials do not promote the best interests of this, any more than other Journals. But, happily, so far it has been possible to y on, we hope with some modicum of success, and *dura ferens finis*, we will endeavour to continue to do so, so long as we we are supported by the sympathetic encouragement of those o are interested in the welfare and development of ports and bours.

nchester Ship Canal Jubilee.

t is unfortunate that the continued existence of a state of r should have interfered with the proper celebration of an niversary of such significance to the Port of Manchester as jubilee of its great undertaking, the Ship Canal. The event notable one and can hardly be passed over without reference past history and the tremendous legal and parliamentary nflict which raged over the inception of the project in the ly eighties of the past century. The outstanding protagonists in the struggle waged by the City of Manchester to acquire the long-desired outlet for its shipping to the open sea have passed away and a new generation has taken their place, but there are still many who can recall the prolonged and, at times acrimonious, agitation in the press and on the public platform, culminating in the crowded meetings in the Free Trade Hall and the Town Hall of Manchester when the project was enthusiastically received, followed by the decision of the City Council to give it official approval and financial support. These meetings and their sequel were the outcome and climax of the vigorous advocacy and untiring exertions of Mr. Daniel Adamson and his associates.

Then ensued a stiff parliamentary fight against adverse vested interests and jealous competitors. Three times was the Bill presented to the Houses of Parliament before the requisite legislative sanction was obtained, and truly enormous sums of money had to be expended on "promotion expenses" and in overcoming opposition. But this was not the end of troubles, which sprang up in other directions. The work was still in its early stages when the matter was complicated by the untimely decease of the contractor, Mr. T. A. Walker, a public works engineer of considerable reputation. Thereafter, the Ship Canal Company took over the conduct of operations and carried them through departmentally. Then financial difficulties manifested themselves and the Manchester Corporation had to be invited to come to the rescue, which they did, promptly and confidently. Finally in 1894, the Canal was completed and ocean shipping made the passage from the Mersey Estuary to the docks at the Port of Manchester.

It was a great and momentous achievement, of which Manchester and its citizens are justifiably proud, and we pay tribute on the occasion of the fiftieth anniversary of the opening of the Canal to the foresight, courage and pertinacity of the promoters of this outstanding engineering and commercial enterprise, which has resulted in the attainment by Manchester of the status of a World Port.

The Port of London and its Thames Frontage.

In an article on the "Future Shape of London," which appeared in *The Times* of April 4th, the Rt. Hon. Thomas Wiles, Chairman of the Port of London Authority, has expressed on behalf of the Authority and of "commercial and industrial

Editorial Comments—continued

river users," their joint views on the subject of the "County of London Plan, 1943," prepared for the London County Council by Mr. J. H. Forshaw and Professor Patrick Abercrombie. Through the courtesy of *The Times* we are enabled to reproduce the article in full: it will be found on a subsequent page. Writing with all the prestige and authority of his official position, Mr. Wiles unhesitatingly condemns the proposals therein put forward for the re-modelling and re-arrangement of the frontage of the River Thames for a distance of some eight miles within the civic area. The Plan, as will be seen in the extract from the L.C.C. Report which follows Mr. Wiles' article, proposes serious interference with the existing lay-out, including the complete removal of the wharves on the north bank of the river from the Tower to the Shadwell Memorial Park, with other clearances at various points extending as far as the India Dock system. On the South bank, numerous wharves between Westminster and London Bridges are to be similarly displaced. The whole of this area has hitherto been devoted to the reception of shipping and to industrial and commercial purposes. In place of these definite features of port business activity, the County Council proposes to substitute, in a large measure, promenades and open spaces for public enjoyment.

Mr. Wiles points out as a fundamental objection to the scheme that it totally ignores the detrimental effect of the proposed changes on the commercial life and enterprise of the metropolis, with inevitable repercussions on its vitality and prosperity. They would, in brief, cut away the very roots of its existence. "The great natural advantages," he says, "conferred by the Thames for overseas commerce and the situation of its estuary were the chief factors determining the origin and site of London. The subsequent co-development of the Metropolis and the Port of London has been due primarily to the provision of progressively modern facilities for handling, distributing and marketing merchandise. Over the years, industries and public utility undertakings in great variety have been established on the river's banks, attracted by the facilities for importing raw materials and exporting finished products and the cheap inter-port water transport available." There is no doubt as to the soundness of this reasoning, and from prolonged personal and intimate knowledge of the port, we warmly support the remonstrance against an indiscriminate interference with the location of its essential business activities under the specious plea of providing additional amenities and recreation for the population.

That such amenities are undoubtedly desirable, wherever they can be provided without detriment to the legitimate functioning of the port, will be freely admitted, but the appropriate place for them is not at the centre of trading operations nor on a river frontage which is particularly suitable for, and indeed, has been consecrated by many years of continued use and progressive development to the furtherance of overseas commerce and shipping.

But it is not to be inferred from our remarks that the industrial and commercial frontage of the Thames is incapable of improvement. Far from it. We consider that there is abundant scope for the removal of obsolete and dilapidated buildings and for the substitution of modern structures of pleasing design and up-to-date arrangement. Our gravamen is directed against the proposed alienation of extensive areas of the riverside from their inherent historic purpose of providing sites for the accommodation of shipping and the cognate industrial activities of the port.

It seems obvious to us, and the opinion has been stated quite clearly in an Editorial Comment which appeared in the issue of this Journal for August last, that the designing or re-modelling of dock systems and riverside facilities is not a matter for architects or civic planners, since these experts seem to be completely under the influence of aesthetic ideas and their impulse is to lay out buildings and thoroughfares in the most artistic manner possible, with little regard for merely utilitarian considerations. Their plans are undoubtedly "pretty," with boulevards and gardens designed, Laputa-like, in ornate squares, rectangles and circles of geometrical symmetry, but in a business are these purely æsthetic considerations must yield place to practical needs which can only be defined by those who have to live and work in the area in question. It is clear from Mr. Wiles' article, as also from the re-modelled dock plan propounded by the Royal Institute of British Architects for the Isle of Dogs, which we criticised in the previously cited issue, that no attempt has been made by the official planners of either body to get into touch with the technical staff of the Port Authority, or with merchants and shipowners in the City in order to ascertain their views or have the benefit of their experienced advice. We unhesitatingly affirm that this attitude of Olympian aloofness is foolish in the highest degree.

Yet not only is advice from quarters best able to give it not sought, but pre-conceived ideas are maintained in spite of adverse expert opinion. The County Council re-assert their contention that a Thames Barrage Scheme appears to be worthy of "full and impartial examination." As a matter of fact, the scheme has been carefully examined and found wanting. Its condemnation was convincing to all but the prejudiced promoters of the scheme. Those of our readers who would like to refresh their memories about the matter will find the vital objections to the barrage set out in an article and Editorial Comment in the issue of July, 1937. Nothing has occurred since then to alter the situation or justify a reversal of the judgment by the competent authorities, who included the pre-War Minister of Transport and the President of the Board of Trade, as well as the Port of London Authority, who, it must be remembered are the body statutorily charged with the maintenance and development of the Port and therefore fully qualified to express a sound opinion.

A Mysterious Subaqueous Explosion.

The Clyde Navigation Trust are at present investigating the circumstances attending a mysterious explosion in a diving bell used in operations on the bed of the river Clyde, which resulted in the death on March 11th of two of their diving staff.

At a meeting of the Trust in April, the Chairman, Mr. William Cuthbert, reported that the finding at the official inquiry was that the explosion had been caused by Marsh Gas. Such an occurrence had never been experienced before in the Clyde waters and other harbour authorities and experts have been asked if they could contribute any information which would throw light on the cause of the disaster.

The peculiarity of the case is that Marsh gas, or light carburetted hydrogen (in chemical symbols, CH_4), is a product of dead vegetable matter and its occurrence is generally associated with coal mining, the gas being known to miners as "fire-damp." Mixed with air, it forms a highly explosive compound, the cause of numerous catastrophic colliery accidents. That such a gas has been evolved from the bed of the Clyde, would seem to indicate either that the diving bell at the time of the accident was located directly over the site of some ebullient carboniferous deposits, or that the gas had escaped through fissures from some lower underground strata. The formation of the gas is frequently to be observed by bubbles in stagnant water in the vicinity of decaying vegetation.

Whatever may be the cause, the matter is of serious and disquieting significance to all harbour authorities who engage in subaqueous operations, especially in the neighbourhood of the Coal Measures or of other carboniferous strata. The result of the Clyde Trusts' enquiry will be awaited with anxious interest. Fortunately, such incidents as the accident in question are rare, and, generally speaking, harbour works, though often difficult and strenuous in their execution, are fairly immune from hazards of an unforeseeable nature.

Hydraulic versus Electric Power at the Quayside.

Our readers will have followed with interest and, we hope, will have derived edification from the controversy which has been taking place in our Correspondence Column over the relative merits of hydraulic and electric power for quay-crane operation. It is a contentious subject, involving a number of indirect, as well as direct, issues, and there are warm advocates on both sides. As we have already commented on the matter in August last, we will leave readers to form their own conclusions.

General view of the Terminal Docks at Manchester.

The Manchester Ship Canal

Jubilee Anniversary

(COMMUNICATED)

Introductory

THE present year marks the 50th anniversary of the opening of the Manchester Ship Canal, whereby Manchester became a sea port, destined to take high rank among the ports of Great Britain.

The first ships to navigate the Manchester Ship Canal entered the terminal docks at Manchester on January 1st, 1894. The Port was ceremonially opened by Queen Victoria on May 21st following.

Historical

The rivers Irwell and Mersey connect Manchester with the sea and from early times this waterway has been used for traffic by small river craft. Proposals to improve this navigation by canalisation date back to the early 18th Century and various projects—each more ambitious than its forerunner—were canvassed from time to time, culminating in the scheme put forward with great force by Mr. Daniel Adamson in 1882, which, after protracted opposition and many vicissitudes, finally materialised.

The first sod was cut at Eastham by the chairman of the Ship Canal Company, Lord Egerton of Tatton, on Noverber 11th, 1887.

Physical Features

The Manchester Ship Canal is a navigable waterway connecting the Mersey Estuary at Eastham with the terminal dock system at Manchester, a distance of 35½ miles.

Proceeding westwards from Manchester: the first 7½ miles is virtually a new cutting taking the general line of the River Irwell, and the next 4 miles, a canalised section of the Mersey The remaining length consists of a virgin cutting of 11 miles to Runcorn, from which point the Canal is cut, or embanked, along the southern fringe of the Mersey Estuary.

The water level at Manchester—some 70-ft. above mean sea level—is maintained by five sets of locks; the lower section of 21 miles between Eastham and Latchford being semi-tidal. The Canal is navigable by ships up to 15,000 tons d.w. capacity.

Commercial Importance

Immediately following its opening the Canal took an important place in the development of Industrial Lancashire and attracted to its banks and to the neighbourhood of its docks a wide variety of industrial undertakings. The growth of its traffic early won for Manchester a position amongst the major ports of the country.

The tonnage handled in 1894 was less than one million tons with a revenue of £98,000. In the intervening years the annual tonnage has touched the 7,000,000 tons mark while the annual revenue has passed £1,500,000. No figures have been available since 1938.

The present capital of the Ship Canal Company is £21,000,000; a substantial part of the stock being held by the Manchester Corporation.

The Company owns and operates the Bridgewater Canal and is a statutory Railway Company operating over 200 track miles of dock railways.

The traffic moving along the Canal increased from a total of 925,659 tons in 1894 to 2,778,108 tons in 1899 and to 5,210,759 tons in 1917.

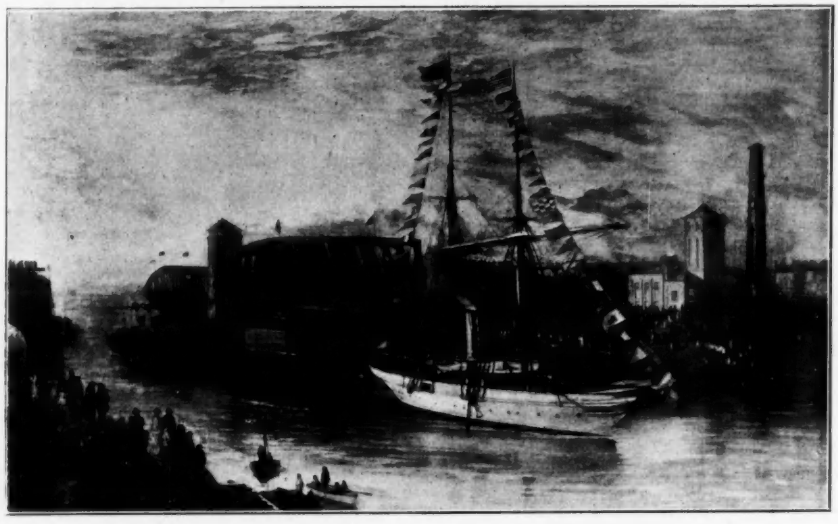
The Opening Ceremony

The official opening of the Ship Canal by Queen Victoria on May 21st, 1894, provided the most impressive spectacle that Manchester, throughout her long history, has witnessed. Writing at the time of the visit an eye witness recorded, with obviously genuine feeling, that while the long procession of royal carriages, with their scarlet and gold outriders and footmen, offered little upon which the eye cared to linger, after the one illustrious figure had passed, there was something overwhelmingly, as well as profoundly, thrilling in the great multitude of human faces all turned in unanimous gaze in her direction wherever she appeared.

The walls of the houses on either side of the route, it was reported, was scarcely visible for them. They fringed the roofs, filled every window, rose tier above tier in improvised balconies and gleamed in an unbroken mass behind the barricades. The

Manchester Ship Canal—continued

enormous assemblage in the street was computed at considerably more than a million, and full-throated roars of welcome greeted the Queen along the entire route.



Opening of the Canal to traffic, January 1st, 1894. The Steam Yacht, "*Norseman*," with Directors of the Company on board, leading a procession of 71 ships.

(From a painting, by James Rudd, in the possession of the Manchester Ship Canal Company)

There were good reasons for this extraordinary display of enthusiasm. On two occasions only during her long reign of 58 years had the Queen previously visited Manchester, and on neither had she seemed to be much impressed by the city. After some caustic, if casual, references to the lack of dignified buildings and to the general ugliness and dirtiness of the place, she coldly recorded in her private diary at the time of her second visit with Prince Albert in 1857: " A very intelligent but painfully unhealthy-looking population they all were—men as well as women." And although these private reflections were not generally known at the time of her visit in 1894, there were many still alive in Manchester who could have recalled, had they wished, how her refusal in 1877 to open the new Town Hall had provoked some spirited criticism from very distinguished personages at the banquet held to celebrate the actual opening of the building by Alderman Heywood, the courageous and radical Mayor of Manchester, of whose politics she had disapproved.

In 1894, however, that was ancient and forgotten history. Great national events had changed not only the country, but the Queen herself. The illustrious age, of which she was the visible symbol, was now quickly drawing to a close. She, herself, had barely seven more years to live. The great majority of people in Manchester had never seen her; she was at the height of her popularity, and the city was thrilled when it was known that, by deliberate choice, she had decided to advertise to the whole world, by personally opening the Canal, her recognition of the importance—the more than national importance—of one of the greatest engineering enterprises of her reign.

In Manchester itself the significance of the undertaking had been appreciated for a long time. Manchester had seen the writing on the wall a dozen years before, when several great industrial firms had left the city for Glasgow. Newcastle, it is true, had previously dredged its way to the sea to the tune of 60,000,000 tons of solid matter excavated and removed, but to bring great ocean-going vessels to a purely inland city 35 miles from the coast, where salt water had never been, was a step not only in the history of Manchester, but in the history of civilisation. All Lancashire, including Liverpool, now recognised the fact, and all Lancashire turned out to celebrate the event as no other had been celebrated before.

The Queen, accompanied among other distinguished personages, by Princess Beatrice and the First Lord of the Admiralty (Earl Spencer) left Windsor by special train at 11.5 a.m. and arrived at London Road Station at 4.27 p.m.—3 minutes before time. By way of Piccadilly, Market Street and Cross Street she left immediately for Albert Square where the Mayor (Mr. Anthony Marshall) presented her with a loyal address which had been adopted at a special meeting of the Council two hours before. The Queen made a short but suitable reply and then proceeded by way of Mount Street, Peter Street and Oxford Street—all lined with great stands—to All Saints where an address on behalf of Owens College was presented to her by Dr. A. Ward, the distinguished Principal. From All Saints she drove along Stretford Road, Chester Road and Trafford Road to Trafford Wharf where a Royal Pavilion had been erected and the Admiralty steamer *Enchantress*, attended by the gunboats *Speedy* and *Seagull*, was waiting to convey her to Mode Wheel. Two or three hours before the Queen's arrival of Trafford Wharf, the stands accommodating 15,000 people, were all filled and a vast crowd lined the approaches and covered the quays. But yesterday, it seemed to those assembled there, a familiar narrow river ran under Trafford Road where now a vast sheet of water carried ships of all nations. From the wharf each one of the Salford basins could be seen and they were all filled with gaily decorated shipping from London, Glasgow, Rotterdam, the Brazils and Latvia.

On board the *Enchantress* the Queen received Lord Egerton of Tatton, the chairman of the Ship Canal Company, who presented her with an Address to which she replied as follows: " I recognise in this great and important undertaking and the admirable engineering skill with which it has been constructed further evidence of the unceasing energy and enterprise of my subjects. I trust that the increased facilities to be afforded by it for direct commercial intercourse by sea with the trade of the world will not fail to be of the greatest advantage to the busy and industrious popu-

Excavation in Progress.

lation of Manchester and the neighbouring district, and I earnestly pray that by God's blessing, this work may contribute to the well-being and happiness of my subjects in the United Kingdom."

Everyone was moved—not least the Queen herself. Immediately after the ceremony she sent for the Mayor of Manchester,

Manchester Ship Canal—continued

Mr. Anthony Marshall, whom she knighted. The Mayor of Salford, Mr. Wm. Bailey, was then summoned and also knighted, whereupon the *Enchantress*, accompanied by the two gunboats, sailed for Mode Wheel, where a salute of guns welcomed the Queen. An electric communication with the centre of one of the piers was established; the Queen pressed a button, the lock gates began to move and she declared the great Canal open. Returning to Trafford Wharf the Queen disembarked and amid cheering, which was prolonged throughout the whole of the return journey, she drove away through the streets of Salford to Exchange Station where she continued on her way to Balmoral—tired, no doubt, but with happier impressions of Manchester than she had formed during her previous visits, for which she expressed her gratitude to Sir Anthony Marshall in unequivocable terms.

The Admiralty steamer, *Enchantress*, upon which the Queen sailed to Mode Wheel, was a paddle steamer with two funnels and was considerably smaller in size than the 1894 Isle of Man steamers. The gunboat *Speedy* was a twin-screw vessel of first class. She had three funnels and drew about 12-ft. of water. *Seagull* was rather smaller.

Legal Notes

Responsibility of Stevedores for Dock Accident

In the December, 1943 issue, a report, under the above heading, was given of a case decided by Mr. Justice Hallett in the King's Bench Division, in reference to the responsibility of a firm of Liverpool stevedores for an accident arising out of the alleged negligence of one of their crane drivers.

An appeal was lodged by Rea, Ltd., the stevedores in question, against the Lower Court Judgment that they were liable by reason of the negligent manner in which the load was being lifted over the ship's side. The appeal was heard in the Court of Appeal on March 28th.

Judgment.

In giving Judgment, the **Master of the Rolls** said the issue first opened was negligence on the part of the crane-driver. If the appeal succeeded on that issue the further question whether the craneman against whom negligence was alleged ought to be treated for the purpose of this case as the servant of the appellants would not arise. The negligence alleged was that the craneman omitted to lift the sling high enough to clear a lifeboat which it was said partly overlapped the hatch, so that the load would pass over the boat. The Judge found that the negligence of the crane-driver was that, while lifting the sling out of the hold it developed a swing which he should have been able to judge whether it was dangerous or not. But the craneman could not judge that until the load was clear of the hatch. The Judge assumed that it was the craneman's duty to form a reasonable estimate of the nature of the swing and to have stopped it if necessary. His Lordship said he could not hold that the craneman could so estimate, but that the person who was in a position to do so was the hatchman. It was his duty to give the necessary signals to the craneman so that the latter could act accordingly.

In the circumstances and on the evidence he could find no negligence on the part of the craneman. In fact, it was the duty of the hatchman to warn the craneman if there was anything dangerous happening. In the result the appeal succeeded on the issue of negligence. There was therefore no need to go into the other question.

Lord Justice MacKinnon and Lord Justice Goddard agreed. The appeal was allowed, with costs. Leave to appeal to the House of Lords was granted.

The fact that goods made of raw materials in short supply owing to war conditions are advertised in this Journal should not be taken as an indication that they are necessarily available for export.

Review

British Railways in Peace and War. pp. 72. Fully illustrated with 66 photographs. Price one shilling. 1944: issued by British Railways Press Office, Waterloo Station, London, S.E.1.

Now that the four great railway companies of Great Britain are formally affiliated with the Dock and Harbour Authorities Association in respect of their dock undertakings, there is not so much incongruity, as might appear at first sight, in giving a review notice of a publication which is essentially and almost entirely concerned with railways, the references therein to docks and harbours being very meagre and almost insignificant.

As regards the railway systems of this country, the booklet is an excellent compendium of their traffic ramifications and activities, and there is much interesting and detailed information to be found in its copiously illustrated pages. The story is told of the development and progress of the four main line railways since their reorganisation on 1st January, 1923, and also of the growth and activities of London Transport from the time of its creation ten years later.

The period in question embraces alike years of peace and years of war, and so covers the varied application of the railway systems to national needs under both conditions; a highly creditable record of service is set forth, showing enterprise and forethought in abundance.

But our readers' interest lies mainly in connection with dock and harbour traffic, and here we confess to a feeling of disappointment. The subject of "Railway-Owned Ports," in so far as it has a section to itself, is dealt with in less than 40 lines, despite the impressive opening statement that the railways own, and are responsible for, the efficient functioning of dock, harbour and wharf accommodation at 76 places, with an aggregate of 95 miles of quays. Thereafter, follow a few general remarks on the change-over to war work which, although involving many adjustments in accommodation and equipment, is dismissed with a brief acknowledgment of the work done by Port Emergency Committees. Our readers will feel that much more might have been said about the strenuous and anxious exertions of port officials and staffs to cope with the arrival at irregular and uncertain intervals of cargo for home consumption and the urgent despatch of military stores and equipment to numerous places abroad. This would not involve the disclosure of official secrets—indeed, much of the exacting work in connection with say, the North Africa expedition is now ancient history and could provide no information of value to the enemy. Three of the illustrations are made to suffice for port operation: one of them with the caption "The ports are busier," is a photograph which seems to have been taken when the whole of the staff had gone home. We feel that the opportunity might have been seized to pay a well-deserved tribute to dock and harbour personnel for their arduous labours; yet the work of railway dock officials is, generally speaking, passed over as if it were a side issue.

Apart from this defect, the volume is a credit to its producers and full of interesting matter admirably presented. It is a record of which the British people may well be proud.

Proposed Sale of Cullercoats Harbour.

It is announced that the Duke of Northumberland has signified his willingness to dispose of his rights in Cullercoats Harbour and the adjoining sea frontage and that the Tynemouth Corporation are in negotiation for their acquisition. The Duke's estate office has intimated that the Duke is prepared after the war, and subject to the opinion of his solicitors, to offer the foreshore and land required by the Council for £500, subject to the following conditions: (1) The due safeguarding of the interests of the fishing community using the harbour as their means of livelihood. (2) The maintenance of the harbour lights and beacons and the rights of the Admiralty and the Board of Trade. (3) The existing tenancies, and in particular an agreement dated 1896 with the Royal National Life-Boat Institution in respect of the lifeboat house and slipway.

"The Future Shape of London"

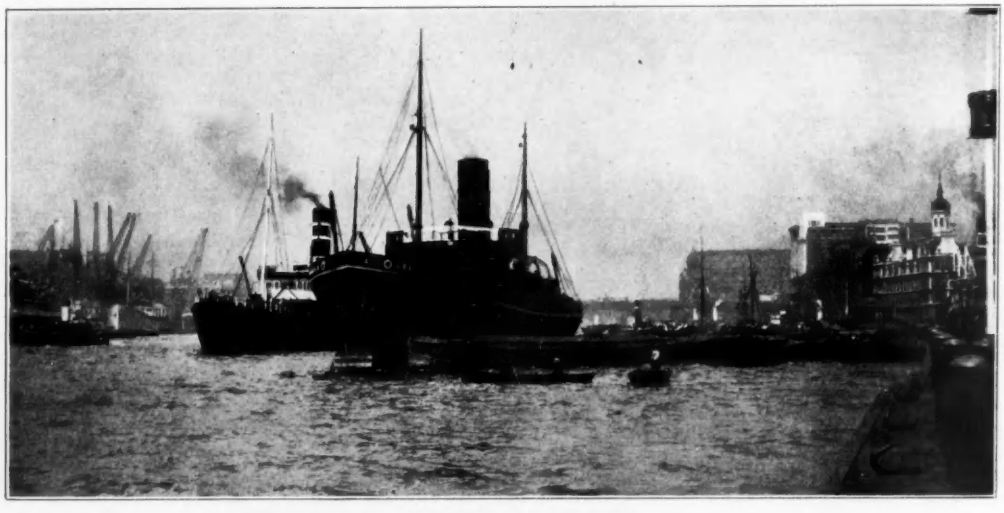
Criticism of the L.C.C. Proposals for Riverside and Market Areas

By the Rt. Hon. THOMAS WILES, Chairman of the Port of London Authority.*

In a serious attempt to assess the merits or demerits of any proposals for the replanning of London it is essential to remember that the opportunities and performances of civic administrators everywhere—in village, city or county—are inevitably largely regulated by the degree of prosperity of the staple industries or trades within their area. The interdependence of the County of London and the Port of London has been observable to a most marked extent throughout the successive phases of their evolution, and their mutual interests have never been more marked than in modern times.

Before the war the annual income of the London County Council was about £21,500,000, whereas half-a-century earlier it stood at only £1,600,000. During the same period the tonnage of vessels using the Port of London rose from 20,500,000 to 62,000,000 net register tons, and the value of the Port's oversea trade (not taking into account coastwise trade) increased from £232,500,000 to approximately £600,000,000. Some 42,000,000 tons of goods a year were handled in the Port before the war, including raw materials to be made into articles for export in London factories. The direct and indirect employment and revenue both local and national, attributable to the activities of the Port of London, although not mathematically ascertainable, are obviously very great; and the high standard to which public services and amenities had been brought by the London County Council before the war would not have been attainable but for a unique expansion of the Port's shipping and international trade. Commercial and industrial river users and the Port of London Authority have therefore approached their examination of the "County of London Plan, 1943," prepared for the L.C.C. by Mr. J. H. Forshaw and Professor Patrick Abercrombie, with a full sense and understanding that the essential feature of London is the Thames.

The great natural advantages conferred by the Thames for overseas commerce, and the situation of its Estuary, were the chief factors determining the origin and site of London. The subsequent co-development of the Metropolis and the Port of London has been due primarily to the provision of progressively modern facilities for handling, distributing and marketing merchandise. Over the years a great variety of industries and public utility undertakings have been established upon the river's banks, attracted by the facilities for importing raw materials and exporting finished products and the cheap inter-port water transport available. Certain others, in addition to the enjoyment of these facilities, utilise river water for industrial processes. Whilst the present is an excellent opportunity to outline a comprehensive programme for the all important re-development of London, it is essential that a practical and realistic view should be taken of the proposals, especially as regards the riverside and market areas. Everything practicable should be done to remedy traffic congestion and to improve immensely living conditions with more open spaces in these areas. In dealing with these problems, however, it is vital to remember that the gravest need of the country after the war will be full employment; that means of livelihood must take precedence over the problematical attractions of riverside gardens which, if laid out on the scale outlined in the Plan, would absorb far too large a proportion of the water frontage of the main artery of the economic life of London.



The Pool of London and its Shipping.

The Port Authority, and the proprietors of riverside accommodations and industries, have done much to improve the Port and its commercial and industrial attractiveness, and they assert that this process must continue since the future of London will certainly not be less immune from keen foreign competition than it has been in the past. The plan suggests the removal of wharves and industry from some 8 miles of river frontage. The provision of open spaces at the expense of depriving industry and commerce of the site of their premises (with a problematical likelihood of their being rehoused in the same neighbourhood) must affect thousands of the population, many of whom rely for their livelihood on riverside premises where work, largely regulated by the tides and the convenience of shipping, is carried on by night as well as during the day and who must therefore necessarily also live in that neighbourhood. If their place of work be removed there will follow the problem of rehousing them near the new sites. But it appears much more likely the removal of wharves would result in unemployment. The proposals for only a few specific reaches can be examined here.

London sea-borne trade commenced in the Upper Pool (the "seaboard" of the City of London and excluded from the L.C.C. report) before the time of recorded history and its growth through

*Reprint (by permission) of a recent article in *The Times*.

The Future Shape of London—continued

many centuries was provided for at riverside wharves east of the City. The plan proposes the sweeping away of the wharves on the North bank from the Tower to Shadwell Memorial Park and other clearances of the riverside intermittently as far as the Isle of Dogs, and to substitute promenades and open spaces.

The threatened wharves are particularly well sited for the trades catered for and London shipowners (ocean and coasting trades), wharfingers, the lighterage trade, and the Port Authority are convinced that interference with the traditional use of this river frontage would be seriously detrimental to trade; and, of course, the clearance of so many warehouses and busy wharves would reduce the resident population for whom the amenities are mainly intended.

On the South bank of the river between Westminster and London Bridges there are about 80 wharves on the stretch of frontage which would be affected by the proposals. Only a few have been demolished and some damaged and partly restored. The Port Authority are of opinion that the frontage below Blackfriars Bridge is essential for use by riverside industries and that the embanking proposals should be confined to a shorter stretch of the river bank extending from the east end of the County Hall to Blackfriars Bridge, and then only if the industries which would be displaced can be suitably accommodated elsewhere on the river front. The proposals for the development of the sections on both sides of the river extending westwards from the City area to the boundary of the County area consist of minor improvements not affecting riverside premises to as great an extent as those already referred to.

It is agreed that the type of industrial use of the river frontage may call for improvement, and possibly open spaces might take the place of out-of-date and inefficient industrial premises, but only if the sites can be spared without detriment to the commercial activities of the Port. The Port Authority do not agree that the principle of forming side ponds would assist in the re-siting of riverside industries. Inlets on the lines suggested, without a natural discharge at their heads, would become mud traps, would be congested by craft lying off the entrances and after a short time would fail to serve the purposes for which they were designed. Improvement of all roads and means of approach to the Port are long overdue and the Port Authority consider priority in reconstruction plans should be given to the provision of adequate road access to all the docks and riverside premises, especially to roadways serving the wharves in the Stepney and Poplar areas.

On the question of the future of the principal London markets, the Port Authority have offered their co-operation to ensure that, if those markets are removed from their present sites, any new sites selected would be the most suitable, not only for market purposes but also for effecting the greatest efficiency and economy in the different modes of transport concerned.

Housing is a matter upon which the Port Authority have no general statutory responsibility. They consider, however, that the housing of dock and riverside workers should, if possible, be provided within easy reach of the dock and river areas. Apart from the possibility of a long journey before an early morning "call," at times prolonged by fog, the cost of daily fares incurred by workers is a matter of considerable importance. On the other hand, blocks of flats should not be built in areas too near the riverside which might either impede industrial development or restrict the provision of factory or warehousing facilities.

The authors of the plan state that a Thames Barrage Scheme appears to them to be worthy of full and impartial examination. Without going into the history of the matter it can be said that the Port Authority have exhaustively examined all the various schemes suggested from time to time and still remain convinced, not only by their own knowledge and experience but by the unanimous views of the various users of the Port qualified to express them, that a scheme for the construction of a barrage in the Thames would be totally impracticable.

As I have said elsewhere I feel most strongly, it has not yet been sufficiently emphasised that unless London is re-established in her pre-war eminence as the centre of international trade all schemes for enhancing her beauty will remain disappointing dreams. London is first and foremost a great sea port.

The London County Council Proposals

In order that readers may be able to appreciate the arguments contained in Mr. Wiles' article and, at the same time, have a fair presentment of the case for reconstruction and development put forward by the London County Council, the following extract, on which the article is based, is taken from Chapter XI of The County of London Plan, 1943, published by Macmillan & Co., Ltd.

River Front Proposals.

In order to exploit the banks of the river for the benefit of the community as a whole and to bring this magnificent natural feature more into the life of the Metropolis, we propose an increase in the length and number of the stretches accessible to the public as open spaces or as sites for non-industrial buildings. We believe that a rationalisation of the industry by the use of two or more storied works in place of the existing one-storey sheds or partially used yards, by providing creeks or side ponds and by concentrating industry and warehouses within reasonable limits, will ensure, as far as possible, that a full and proper use is made of the frontage land. The total industrial capacity need not be reduced on account of this additional provision for other uses. The probability is that it could be greatly increased. Excepting special cases, those industries, which do not require contact with the river for their operations either for transport or manufacture, should, in future, be discouraged from establishing or re-establishing themselves on the frontage, and when decentralisation of industry is considered, the position of the existing riverside industries not dependent on the river should be reviewed.

The river, from the county boundary at Woolwich to the bend at Limehouse where it straightens out after rounding the Isle of Dogs, has many established industries and provides entrance to the major docks. Before the large docks were built, the Pool, east of London Bridge, was the main docking area but the centre has since shifted eastwards, and the location of wharves and warehouses west of this bend now has less justification. Sentiments of tradition, if the economic basis has disappeared, hardly justify the continuance of the use for wharves and warehouses of the entire river front as far as Blackfriars Bridge on the north and the County Hall on the south. By rational replanning through a long-term policy, we propose that the river front of Stepney, from the Tower to King Edward VII Park, should in the main be freed for open space and riverside amenity. The future of the Katharine Dock has, we understand, been under consideration for some time. If it were decided that the dock is redundant, we suggest that it might become the site of a riverside open space for Stepney as well as a park-setting for the Tower of London. In conjunction with the prospective Tower Hill Improvement in which the City Corporation has an interest, these proposals would establish a worthy setting for this notable monument and museum. On the river front a restaurant and cafe, dance and concert halls, with children's recreation facilities adjacent, are visualised. There would also be sufficient areas to provide walks and attractive rest gardens.

Ultimately, on the east, a green strip would supplant the narrow stretches of warehouses which occupy sites of uneconomic depth and bring the redeveloped areas of Wapping into association with the river. The new open space would link up the existing parks and provide a continuous treed riverside walk from the Tower to King Edward VII Park. The removal of the warehouse "wall" separating the residential area from the river would transform this district; it would permit redevelopment round the two docks with distinct advantage to inhabitants and to the Port Authority. Further eastward another riverside open space is proposed east of Regent's Canal Dock, at the bend of the river, with a parkway approach from Commercial Road East.

The reduction in area of warehouse and wharves here and elsewhere would be compensated for by additional areas around

The Future Shape of London—continued

the London Docks, and by a rationalisation of the similar facilities around the main docks, particularly the Surrey Docks, where several pockets of deteriorated residential property should eventually be eliminated.

On the Bermondsey river front it is proposed to extend Southwark Park to the river and provide a green open space strip along the front to the east as far as the Surrey Docks, and to the west past Cherry Garden Stairs and returning on to Jamaica Road in the neighbourhood of Fountain Dock and Vienna Road. This section of the river commands fine panoramic views of both the Tower and the north bank, and full advantage should be taken of these in the architectural planning and layout.

The stretches of the river bounding the Isle of Dogs, with Deptford, Greenwich and Woolwich on the opposite bank, come within the main port and industrial area of London. Here we propose that public access to the front should be of a smaller extent and might take the form of small gardens of restricted length so that the general public can enjoy the river scene of shipping and other activities. The main proposals on these lines comprise riverside open spaces on the "Island," including an extension of the Isle of Dogs Gardens; in Greenwich by the Royal Navy Victualling Yard, which would serve the borough of Deptford; in Greenwich, an extension and widening of the promenade in front of the Royal Naval College, east and west, and a more spacious layout for the approach to the pier; in Woolwich, two interspersed riverside gardens, in conjunction with playing fields to serve the industrial areas nearby, and one of a more ornamental character on each side of the present Woolwich Ferry approach and in front of the main shopping centre.

At all these points the river front open spaces would open up ideal adjoining sites for public buildings facing on to the open spaces. Thus embellished and provided with landing piers, they would form points of access along the river for travellers by boat.

For the river banks west of Tower Bridge up to Vauxhall Bridge, the proposals aim at raising the standard of the river bank treatment, so as to make the river the main highway of central London, flanked with fine buildings and embankment roads in a setting of trees and riverside gardens. The South Bank which, by reason of its past history, warrants special consideration, is dealt with later in this chapter. Consideration, however, should not be restricted to special sections of the river at this point. The river bank treatment from Lambeth Bridge to Vauxhall Bridge has marked characteristics of *laissez-faire* in its planning and architectural design, in spite of the fact that many of the buildngs are of recent construction. The river front treatment needs to be considered as a whole.

Beyond Vauxhall Bridge, on the north side, the proposals include a clearance of the wharves and industrial buildings in Pimlico, so that the residential areas have no barrier between them and the river, and a continuance of the Chelsea Embankment as far as Wandsworth Bridge, with a few small riverside open spaces alongside it. In Fulham, it is proposed to make the greater part of the river banks north of Fulham Palace open to the public by finding alternative sites for some of the industries on the thin strip of land, which prevent the people of Fulham enjoying the benefits of being a riverside borough, and by giving public access to greater lengths of the private open space fronting on to the river. In Hammersmith, an open space in front of the new Town Hall, and a general co-ordination of the existing riverside paths and walks, are proposed. This will involve eliminating several pockets of industry. On the south side, new open spaces are proposed at Vauxhall Bridge, Nine Elms and St. Mary's Church, Battersea, and it is suggested that Wandsworth Park should be linked by a riverside walk to the embankment road west of Putney High Street.

These open spaces are located, where possible, at points giving the best views of the river, and are conveniently situated to serve large residential areas in the hinterland, where such amenities are conspicuously absent. The aim has been to provide every riverside district with a riverside open space. The following table summarises the re-allocation of river-front use and comparisons can be made with the existing conditions, to which the figures in brackets relate:

Analysis of Proposed Use of Thames River Frontage

Use	Length in Miles		Percentage of Total Length	
Industry	12.8	(14.7)	32	(37)
Wharves and Warehouses	6.2	(12.4)	16	(31)
Railways	.5	(1.8)	1	(5)
Public and business buildings	3.1	(2.6)	8	(7)
Residential	3.2	(1.8)	8	(5)
Private open space with no public access	1.8	(2.4)	5	(6)
Open space with public access	11.7	(3.6)	30	(9)
Total	39.3 miles		100 per cent.	

The main changes are in industry, wharves and railways, which together have been reduced from 73 per cent. to 49 per cent. of the total length, and in open space with public access, which has been increased from 9 per cent. to 30 per cent. The small increases in river front used for public, business and residential buildings should be considered in relation to the increase in public open space which in many cases lies between the buildings and the river.

The length of embankment as proposed totals 11.7 miles, or 29 per cent. of the river front, as compared with the 5.8 miles, or 14 per cent. as existing. Public open space and embankment, as proposed, together give a length of 18 miles or 45 per cent. of the river front accessible to the public, as compared with 10.2 miles or 25 per cent. under existing conditions. We believe that these changes, although substantial, are no more than London and her "Father Thames" demand.

Lastly, we believe there is a future use of the river for pleasure trips. In conjunction with the existing and proposed riverside open spaces and embankment roads, we suggest, in due course, the provision of properly equipped landing stages for steamers and motor-boats. As pointed out in Chapter Three, the river itself is the largest open space in the County and its use for sport and recreation is capable of development.

[A plate of two plans accompanies this section of the report, which, unfortunately, it has been impracticable to reproduce].

The London, Midland and Scottish Railway and their Waterways

Proposed Abandonment of Certain Canals

At a special meeting of the shareholders of the London, Midland and Scottish Railway held in London at the end of March, a proposal was discussed and approved for the closure to navigation of 243 miles of the Company's waterways in the Huddersfield and Glasgow areas. To achieve this object a Bill is being promoted in Parliament.

Lord Royden, chairman of the L.M.S., said that the company's undertaking included a considerable number of canals, with a total of more than 500 miles of waterways. On some 240 miles of waterways, traffic had declined and had in many cases ceased, but the company were under statutory obligations to maintain them up to the full standard necessary to enable barges to pass. The purpose of the Bill was to obtain relief from the obligation to maintain them at navigation standards. Among the canals to be closed was the greater part of the Huddersfield Canal.

The meeting further agreed to an application to the Minister of War Transport for a warrant authorising the abandonment of the Monkland Canal, which extends 13 miles from Glasgow to Airdrie. Lord Royden stated that there had been no traffic over this canal since 1934, and there was no likelihood of traffic being resumed. It is understood that the Glasgow Corporation are desirous of acquiring the Canal site for the purpose of constructing a road thereon and negotations to this end are in progress with the Railway Company.

Notable Port Personalities

XLI—Mr. Harry Parsons

Mr. Harry Parsons, J.P., was until recently Chairman of the Southampton Harbour Board, a post he has filled with distinction for 21 years.

During this time the Port and Harbour of Southampton have undergone tremendous developments in the form of the New Docks built by the Southern Railway Company with the co-operation of the Harbour Board, and also the establishment of the Marine Air Base in Southampton Water, pre-war. This was due largely to Mr. Parsons' efforts and more recently he has taken his share in the preparation of plans for the proposed International Land and Water Air Base.

Mr. HARRY PARSONS, J.P.

At present Mr. Parsons is the representative of the Southampton Harbour Board on the Dock and Harbour Authorities' Association, taking care also of the interests of all the South Coast Ports on that body.

Mr. Parsons is a Justice of the Peace for Southampton, and for many years a Member of the Institution of Mechanical Engineers, whilst in his younger days he was one of a number of racing cyclists and in 1890 held all the Track Records from one hour to three hours.

Apart from associations connected with the Engineering and Shipbuilding Industry and that of Motor manufacture, Mr. Parsons espoused whole heartedly Chamber of Commerce work, and has had a good deal to do with the development of the Southampton Chamber since 1921, of which he is a Past President. He is also a Vice-President of the Association of British Chambers of Commerce.

Appointment of Swedish Port Director.

The announcement has been made of the appointment by the Malmö Harbour Board of Mr. Nils Olaf Lenander, Managing Director of the Malmö Free Port Company, to the post of harbour director, with a continuation of his position with the Free Port Company. Mr. Lenander has been with the Malmö Harbour Board since 1912.

Medical Treatment for Dockers

Opening of Additional Centre at Liverpool Docks

A second medical services centre has been opened in one of the transit sheds at the Gladstone Dock, Liverpool. It is fully equipped with up-to-date apparatus for the expeditious treatment of minor injuries, and is staffed by two State registered nurses under the supervision of Dr. E. Holland, the director of the Mersey Dock Medical Services.

The Mayor of Bootle, in opening the new medical centre, said that he had read of the wonderful work done in the first centre at Huskisson dock, especially in the prevention of more serious injury to dock workers. It was a wonderful thing that the men had somewhere to go where they could get speedy attention to their injuries, and there would be a wonderful saving in time both to the men and to their employers. He knew the splendid work that was being done at the docks in shipping, transport and ship-repairing, and he would like to assure those who were carrying out that work of the wide appreciation of all that they were doing.

Mr. R. J. Hodges, general manager and secretary of the Mersey Docks and Harbour Board, expressed the opinion that the introduction of these medical centres on the dock estate was going to prove a revolutionary step in the history of Mersey dockland. He said that the experience already gained at the first centre, opened at the Huskisson dock last October, was that the dockers and all employees on the dock, to their great credit, never swung the the lead but genuinely appreciated that they now had a centre to go to in case they were injured and needed treatment. The new centre at Gladstone dock would cater for about 10,000 dock workers.

Development of Natal Fishery Harbour

Report of Reconstruction Commission

In the third interim report, recently issued, of the Post-War Works and Reconstruction Commissions to the Government of Natal, a strong recommendation is made for investigation into the possibility of developing Port Shepstone as a Fishery Harbour.

A witness representing possibly the largest canning company in Natal had stated, says the report, that his company would be ready to establish a fish canning industry at Port Shepstone if adequate supplies of fish were available, even if the supply was seasonal over three or four consecutive months of the year. He also stated that a market existed not only in the Union of South Africa but also in the West African States.

"Your Commission is in complete agreement with the foregoing opinion. All the evidence led shows that a large and untapped food supply, the source of a potentially important industry, is awaiting the incentive of a Government decision to exploit it by providing the necessary harbour facilities for such exploitation.

"Your Commission, therefore, stfongly recommends that the Union Government should be approached with a view to an immediate investigation being carried out by a qualified marine or harbour engineer with a view to establishing the cost of the necessary harbour development works for this purpose at Port Shepstone."

The report is signed by Mr. D. E. Mitchell, M.E.C., Chairman, and Messrs. A. V. Allan, W. P. Bawden, C. E. James, E. B. Scott and T. M. Wadley.

Record Cargo Discharge at Glasgow.

On April 14th 2,100 tons of refrigerated cargo were discharged at the port of Glasgow by the Clutha Stevedoring Company, Ltd. This is claimed to be record at the port for the class of cargo. A earlier days record of 1,750 tons had been established by the same company a fortnight previously. Eleven gangs of dockers worked from 8 a.m. to 9 p.m., and two gangs from 11 p.m. to 8 a.m. The cargo consisted of meat, butter, and cheese and came from the Dominions.

Notes of the Month

Death of Retired Harbour Master.

The death has occurred, at the age of 92, of Captain Gilbert Gray, Lerwick, who was for many years, harbour master there and retired twenty-two years ago.

Rise in Port Rates at London.

On April 17th there came into force an increased scale of rates and charges levied by the Port of London Authority and by the London Association of Public Wharfingers, the general effect of which is an increment of about five per cent. in the first case and five points in the second.

Fowey Harbour Dues.

Beginning April 1st, a new scale of harbour dues came into force at Fowey. Vessels entering the port and trading coastwise are required to pay dues of 4d. per ton register, an increase of 1d. per ton register on the previous rate. In the case of all other mechanically propelled or sailing vessels the dues have been raised from 4½d. to 6d. per ton register.

Appointment of Dock Manager at Plymouth.

In the absence of Mr. L. J. L. Lean who has temporarily vacated the position in order to take up special duties, Mr. R. H. L. Bate, assistant manager since October, 1943, at the Great Western Docks, Plymouth, has been appointed manager. At his departure, Mr. Lean was presented with a gift by his colleagues and members of his staff.

Age of Merseyside Dock Labourers.

During a case heard recently in the Liverpool County Court, a port labour inspector, giving evidence said: "We have at least two men aged 80 doing full work and one is working under the guaranteed scheme." It was also stated that men unfit for heavy work were allocated to jobs as landing men, rail men and hatch men, but such men did not come under the guaranteed scheme.

Beira becomes a Free Port.

The important port of Beira in Portuguese East Africa has been declared a "free port" in order to facilitate the transport of raw materials to and from the interior of the African Continent in connection with post-war reconstruction schemes. Quays, warehouses, and other installations at Beira will be freed of all taxation except industrial contribution. All material for building factories and offices and all machinery imported to equip them will be free of duty, while the industrial tax on raw materials produced in Mozambique will be reduced by half.

Foreign Shipping Traffic of Swedish Ports.

Provisional statistics relating to the foreign-going shipping traffic of Swedish ports last year, compiled by the Swedish Board of Trade, show that the arrivals and sailings of Swedish vessels totalled some 8,944,000 tons net, an increase of 228,000 tons compared with 1942; arrivals and sailings of foreign tonnage declined by 381,000 tons to 10,674,000 tons. Compared with 1939—which can be considered to represent pre-war conditions, since the first four months of the war did not greatly affect Swedish foreign trade—last year's foreign-going shipping trade declined by 60.7 per cent.

Extensions to Gothenburg Fishery Harbour

Application has been made by the Gothenburg Harbour Board to the City Council for a grant of 2,600,000 kroner to be expended on extensions at the Fish Harbour.

The project includes a new auction hall and a new building containing packing rooms, etc. The auction hall will be 15 metres wide and 115 metres in length. The packing building will have a basement, ground floor, and two upper floors; packing and forwarding work will be done on the ground floor, there will be offices on the upper floors, and the basement will comprise cold stores and refrigerating plant.

New Tyne Pilot Master.

Captain Henry Row of Whitley Bay, Master of Trinity House, Newcastle, has been appointed Pilot Master under the Tyne Pilotage Authority in succession to Mr. Wm. Marshall, who has retired.

Southampton Harbour Board.

Following changes which have taken place in the representation of external bodies on the Southampton Harbour Board, Mr. H. A. Short, M.C., Docks and Marine Manager, Southern Railway, has been elected Chairman of the Board in succession to Mr. Harry Parsons, J.P., and Alderman T. Lewis of the Southampton Corporation, deputy chairman, in succession to Sir Sidney Kimber.

London Port Employers' New Address.

The Secretariat of the Port Employers in London, the Port of London Local Joint Committee and the Port Labour Executive Committee has been transferred to Plantation House, Fenchurch Street, E.C.3. All future communications to the above-named organisations should be addressed to the Secretary, Mr. E. J. G. Weare, at the new address. Telephone: Mansion House 1415-8.

Spanish Shipping Traffic in 1943.

It has been stated by Senor Rotaeche, Spanish Secretary of State for the Mercantile Marine, to the Madrid financial Journal *Economia Mundial* that in spite of war-time difficulties the merchant fleet (both sea-going and coasting) carried a total of 9,100,000 tons of cargo, against 7,900,000 tons in 1942.

One of the most striking features of the year's trade was the decline in phosphate imports resulting from the American occupation of French Morocco in November, 1942. In normal times Spanish imports of this commodity totalled between 500,000 and 600,000 tons a year, but in 1943 they amounted to only 65,000 tons, against 165,200 tons in 1942.

Use of Port of Beira Entrance Channel.

By the passage of the sloop, *Bartholomew Diaz*, the Carmona Channel at the Port of Beira, Portuguese East Africa, has been opened for experimental daylight use. The vessel, drawing 20-ft., passed through one and a half hours after low water. The Carmona Channel will not be put into full time use until substantial light-buoys are available, nor will the old Portella Channel (Bar) be abandoned until the repairs to the dredger *Irma Pauline* have been completed, so that any silting in the Carmona Channel can be adequately dealt with. The increased depth of the new entrance channel means that in future ships drawing 29-ft. can enter the Port of Beira any day of the year subject to the Port Captain's agreement.

Clyde Navigation Trust.

At a meeting held in March, the Clyde Navigation Tust approved the suggestion that a Government survey be made of the route for the proposed ship canal connecting the Firth of Clyde and Firth of Forth without in any way committing themselves for the present to approval of the project. A proposal by Mr. Tom Macpherson, Regional Port Director for Scotland, that a post war development joint committee be formed to discuss Clyde port development, was not approved. This plan was first mooted some months ago, when competitive development was suggested at Greenock and Ardrossan, the Regional Port Director considering that mutual consultation of this post war problem might be of value. Mr. Macpherson personally attended the February meeting of the Trust and gave his proposals to members. The Trust, in refusing to co-operate, indicated that when the Ministry of War Transport considered the time ripe for a single control to operate on ports on the Clyde, they would welcome a public inquiry instituted by the Minister. They would meantime take no initiative in promoting an Order.

Correspondence

To the Editor of "The Dock and Harbour Authority."

Electric versus Hydraulic Quay Cranes.

Dear Sir,—

In reply to Messrs. Dalziel and West (their letters of the 8th January) may I again reiterate that the hydraulic and electric cranes taken for test were standard general cargo quay cranes, and as such, each had an overload capacity of 25%.

I am quite aware that for coaling cranes utilising skips where time is an important factor, accelerations greatly in excess of those cited can be obtained, incidentally at the expense of heavy current demands, but for a general cargo crane where the total time of a complete crane cycle may be as great as two minutes, I should hesitate to recommend high acceleration with the attendant heavy current demand, wear of controller contacts, together with increased duty upon the mechanical transmission, for the purpose of saving a few seconds on the total time of a complete crane cycle.

Dealing particularly with Mr. West's remarks, I fully agree with his indication of the reason for the apparent discrepancy, but I cannot agree that the kinetic energy of the rotor, gearing and brake drum, amount to only 50% of the total kinetic energy of the crane hoisting motion, but propose dealing with this at some length later.

Regarding the question of creeping speeds, I agree with Mr. West, but would again point out that the cranes in question are standard cranes in both cases, and if special facilities were provided as suggested for the electric crane, then it would be quite possible to obtain extremely low creeping speeds with a hydraulic crane provided with commensurate facilities.

In reply to Mr. Dalziel, the method was that usually used for the purpose of testing crane hoisting speeds supplemented by the use of calibrated tachometer, wattmeter and ammeter in order to ascertain the time of the acceleration period, a graph connecting distance of hook travel with time was also taken and from this, acceleration was obtained as a further check. The motor is a 60 h.p. 720 r.p.m. induction motor having a wound rotor, the rotor resistance being cut out by the usual type of hand-operated controller, the nature of the electric supply being 400-volts, 3-phase, 50-cycles.

It is not permissible to neglect the kinetic energy absorbed by the moving parts of the electric crane, as actually this is far greater than that of the rising load itself, and in this connection, I would refer Mr. Dalziel to the paper on this subject by Anderson in the J.I.E.E., vol. 90, part 2.

Generally for loads lifted at low speeds, say from 60-ft. to 80-ft. per minute, the kinetic energy required to accelerate the load from rest to full speed is in the range of from 5 to 7-ft. lbs. per b.h.p., and in the particular case, i.e., from rest to 240 f.p.m., this value is 20.6-ft. lbs., whereas for a 60 b.h.p. motor of normal design running at 720 r.p.m. the kinetic energy required for acceleration of the rotor from rest to full speed is 244-ft. lbs. per h.p. This latter figure is to be expected in view of the relatively high velocity of the rotor at the radius of gyration which is in the range of 50-ft. per second. From the above it will be realised that the kinetic energy of the rotor or armature and brake drum influences the time of acceleration to a far greater extent than the load itself, and in the case of the crane under consideration in order to obtain acceleration equal to that of the hydraulic (as tested) namely, from rest to full speed in 2 seconds, the motor must produce about two times full load torque.

In the case of the hydraulic crane, however, the kinetic energy of the ram on account of the low velocity (40-ft. per minute) is almost negligible and that of the column of water even less, so that provided the pipe and valve areas are large enough there is no difficulty in obtaining acceleration from rest to full speed in less than one second if required.

Using the formula by Anderson which is quite rational:

$$t = \frac{S}{T \times 5.5 \times k}$$

k = .5 upon assumption that acceleration is uniform.
T = percentage of full load available for acceleration—in this case 32.5.
S = total kinetic energy required during acceleration per h.p.
t = time of acceleration in seconds.

I have calculated the times for accelerations for the electric and hydraulic cranes upon which the tests were made and attach the results.

It is agreed that drainage and heating cost money, but only over a relatively small period of the year in this country, and I would suggest that the keeping clean of insulation, re-varnishing, etc., in order to keep the smooth surfaces indicated by Mr. Dalziel also cost money, and I can only confirm my previous statement that my experience of a crane installation having more than 1,000 cranes with capacities of from 30 cwts. to 50 tons, approximately half of which are electric, indicates very definitely that the maintenance costs of the hydraulic type is very much less than the electric.

Yours faithfully,

C. H. NICHOLSON,

Docks Machinery Engineer.

London & North Eastern Railway,

Hull.

April 6th, 1944.

Appendix

Calculation of time of acceleration of the hoisting motion of a 3-ton electric crane having a hoisting speed of 200 f.p.m. at full load, and a 3-ton hydraulic crane having a hoisting speed at full load of 240 f.p.m.

Electric Supply Characteristics, 400-volt, 3-phase, 50-cycles
Hydraulic Supply Characteristics, 700 lbs. per sq. inch.

Electric Crane

Motor b.h.p. (rated) at full load = 60
Motor h.p. (actual) at full load = 56.5
Crane efficiency by test 65%, i.e., electrical energy to load energy.
Motor efficiency = 90%.

$$\text{Mechanical efficiency of crane} \frac{.65}{.90} = 72\%$$

$$\text{Net h.p. for load} = \frac{3 \times 2240 \times 200}{33000 \times .72} = 56.5 \text{ h.p.}$$

To find K.E. of rotor:
W, weight of rotor 423 lbs.
Diameter of rotors 18-in.

$$k, \text{ radius of gyration (Broughton's approximation)} = \frac{18}{2} \times .8 = 7.2\text{-in.}$$

$$\omega, \text{ angular velocity radians per sec} = 2\pi \times \frac{720}{60} = 75.4$$

$$I, \text{ moment of inertia of rotor } mk^2 = \frac{423}{32.2} \times \left(\frac{7.2}{12}\right)^2 = 4.73$$

$$KE \text{ of rotor} = \tfrac{1}{2} I\omega^2 = \tfrac{1}{2} \times 4.73 \times 75.4^2 = 13{,}500\text{-ft. lbs.}$$

$$KE \text{ in terms of full load h.p.} = \frac{13{,}500}{56.5} = 244\text{-ft. lbs./h.p.}$$

Calculation of K.E. of brake drum coupled direct to motor shaft:
W weight of drum 225 lbs
Diameter of drum 21-in.

$$k \text{ radius of gyration (Broughton's approximation)} = \frac{21}{2} \times .8 = 8.4\text{-in.}$$

$$\omega, \text{ angular velocity, radians per sec.} = 2\pi \times \frac{720}{60} = 75.4$$

$$I \text{ moment of inertia } mk^2 = \frac{225}{32.2} \times \left(\frac{8.4}{12}\right)^2 = 3.43$$

$$KE \text{ of drum} = \tfrac{1}{2} I\omega^2 = \tfrac{1}{2} \times 3.43 \times 75.4^2 = 9{,}800\text{-ft. lbs.}$$

Correspondence—continued

KE in terms of full load h.p. $= \frac{9800}{56.5} = 177$-ft. lbs./h.p.

Kinetic energy of gears, barrel, clutch, etc. = 5,911-ft. lbs.

This KE in terms of full load h.p. $= \frac{5911}{56.5} = 104.5$-ft. lbs./h.p.

K.E. of load $= \frac{WV^2}{2g} = \frac{3 \times 2240 \times 3.33^2}{64.4} = 1160$-ft. lbs.

$= \frac{1160}{56.5} = 20.6$-ft. lbs./h.p.

$t = \frac{S}{T \times 5.5 \times .5} = \frac{20.6 + 177 + 244 + 104.5}{32.5 \times 5.5 \times .5} = 6.62$ secs.

Hydraulic Crane

3 tons @ 240 f.p.m.

Crane efficiency by test—70%
Jigger efficiency = (.86—.02m) = .74 where m = 6
hence efficiency of crane sheaves and rope excluding jigger

$= \frac{70}{.74} = .945$

$\therefore$ h.p. at jigger due to load $= \frac{3 \times 2240 \times 240}{33000 \times .945} = 51.75$ h.p.

Load K.E. $= \frac{WV^2}{2g} = \frac{3 \times 2240 \times 4^2}{64.4} = 1670$-ft. lbs.

Ft. lbs. per h.p. $= \frac{1670}{51.75} = 32.4$

Ram K.E. $= \frac{WV^2}{2g} = \frac{6000 \times (4/6)^2}{64.4} = 41.4$ (approx.)ft. lbs.

Ft lbs. per h.p. $= \frac{41.4}{51.75} = 0.8$-ft. lbs./h.p.

NOTE.—In view of relatively small weight of column of water in cylinder, this can be safely neglected.

$t = \frac{S}{T \times 5.5 \times .5} = \frac{32.4 + .8}{25 \times 2.75} = .483$ sec.

It is obvious from the above that the K.E. of the load and ram and crosshead have little influence upon acceleration; actually acceleration is solely dependent upon the size of the pipes and mains and valves.

For complete acceleration in 2 seconds the percentage power requirements are:

$T = \frac{S}{tx\ 2.75} = \frac{33.2}{2 \times 2.75} = 6\%$

This, in the particular case was only available owing to pressure drop at the hoisting cylinder which was from 700 lbs. per sq. in. to 600 lbs. per sq. in. during the acceleration period.

Maximum b.h.p. of jigger at 700 lbs. per sq. in.

B.H.P. $= \frac{A \times P \times v}{33000} \times .74 = \frac{103.8 \times 700 \times 40 \times .74}{33000}$

= 65 b.h.p. (v in f.p.m.)

H.P. required for full load acceleration in 2 secs. = 51.75 x 6% = 3.1.

Working back for time of acceleration.

Total ft. lbs. required = 1670 + 41.4 = 1711.4-ft. lbs.

Total energy available = 3.1 x 550 = 1710-ft. lbs. secs.

$t = \frac{2 \times 1711.4}{1710}$ assuming uniform acceleration = 2 secs. approximately.

To find pressure on ram required to give this acceleration:

$51.75 + 3.1 = \frac{\text{area of ram x press x v ft. p.m. x .74}}{33000}$

$54.85 = \frac{103.8 \times \text{press} \times 40 \times .74}{33000}$

$\therefore$ Pressure $= \frac{54.85 \times 33000}{103.8 \times 40 \times .74} = 590$ lbs.

This figure is borne out by test as pressure during acceleration taken adjacent to cylinder dropped to 600 lbs. per sq. in.

Eastern Canadian Ports in 1943

Traffic on the St. Lawrence and the Atlantic Littoral

At the Annual General Meeting in Montreal on February 9th, of the Shipping Federation of Canada, the president of the Association, Mr. L. Eric Reford, made the following observations on the effect of U-boat operations on Eastern Canadian ports in 1943.

"The diversion of ocean-going vessels from the St. Lawrence route during the past year has resulted, of course, in a great curtailment of port activities, and the situation was naturally an unfortunate one for a large number of shore workers and others engaged in the manifold services connected with shipping. If employment had not readily been available in other fields considerable distress would have been caused. This temporary interruption, in fact, illustrates clearly the economic dependence of the province of Quebec, and particularly the city of Montreal, on the normal flow of international trade. It is to be hoped that the successful combating of enemy attack will enable a substantial and regular ocean traffic on the St. Lawrence to be resumed.

"In the circumstances, a heavy strain has continued to be imposed on our Atlantic ports during the whole of the past year. I consider that great credit is due to the operators of those ports and to certain Government agencies, including the Ministry of War Transport of the United Kingdom, and the railways, for having dealt with the required volume of traffic. While there is every advantage to be gained in using to the maximum the Atlantic ports, which are the North American rail terminals and the shortest routes to Great Britain, I consider it desirable that steps be taken to avoid over-taxing their capacity by the full use of the St. Lawrence ports. It is only in this way that Canada can accommodate increased shipping and make its greatest contribution towards supplying the fighting fronts."

He added the following particulars respecting navigation on the St. Lawrence during 1943.

The first ocean vessel to arrive in Montreal harbour in 1943 reached the port on May 24th. The last ocean-going vessel cleared from the harbour on December 13th. The harbour was therefore open for a period of 204 days in 1943. Water levels in the St Lawrence Ship Canal were well maintained during the 1943 season of navigation, the level at Montreal being slightly higher than in the previous year. In the interest of war economy dredging operations in the Ship Canal were again curtailed, but a limited amount of maintenance work continued to be carried out.

New Floating Dock for Port of Gothenburg.

A floating dock of 2,250 tons lifting capacity for service in the Port of Gothenburg, Sweden, was launched during the month of March. The dock will be moored at the end of the Slip Harbour, adjoining the ferry berth.

Tidal Levels of the Thames

The Origin and History of Trinity High Water†

By Wm. B. HALL, M.Inst.C.E.*

(Continued from page 285)

First Geodetic Survey 1840—1860.

The first geodetic survey of England and Wales took place between 1840 and 1860. It was undertaken by the Ordnance Survey Department and was based upon a level or datum assumed to be the mean sea level at Liverpool. Throughout the country the familiar broad arrows, termed bench marks by the surveyors, were cut in the walls of buildings and other stable places and the heights of these marks above the assumed datum were given on the Ordnance Maps .

London was levelled just prior to 1850 and naturally the surveyors of London began to relate the well known Trinity High Water Marks to the new bench marks. It was found as has already been explained that the Trinity marks when levelled to adjacent bench marks, did not have a uniform value and indeed the value varied so considerably that the Trinity High Water Marks became useless for any exact levelling whatever. Possibly a small part of the total error was due to errors in the values of the bench marks, but in view of the confusion of thought which has attached to Trinity High Water Mark generally and notably the apparent inability of surveyors to distinguish between the levels of the Hermitage and Shadwell Stones and the level of the dock water represented by the figure XXIII at Wapping Entrance, it is most probable that the greater part of the error was in the Trinity Marks.

At the same time an attempt was made to discover the **true** value of Trinity High Water in relation to Ordnance Datum but unfortunately the Trinity Stone at Hermitage Entrance, which was the true Trinity Standard of John Rennie and the datum of many tidal observations, was not chosen and, instead, levels were apparently taken of the marks representing the surface of the water in London Docks which was probably 2-in. higher than the true Trinity Standard.

The Ordnance Survey Department compared the levels of the tide gauges at Shadwell Entrance and Hermitage Entrance, with adjoining bench marks and found that the levels of the marks at these places were as follows:—

Hermitage. 12.476-ft. above O.D.
Shadwell. 12.590-ft. above O.D.

The mean of these gives the value 12.53-ft. above Ordnance Datum which has up till now been the accepted relation between Trinity High Water and Ordnance Datum. The refinement of the second decimal place is in rather sharp contrast to the erroneous nature of this value.

To anticipate a later chapter on the **Second** Geodetic Levelling it may be noted here that by adopting recently published values of the same two bench marks the value of Trinity High Water would be 11.14-ft. above Newlyn Datum.

The Thames Conservancy Board—1857.

In January, 1857, the First Commissioner of Works received a report from Commander Edward Burstal, afterwards first Secretary to the Thames Conservancy Board, on the state of the River from Putney to Rotherhithe, in which he made the erroneous statement that Trinity High Water had parliamentary authority:

"The Datum (that is, of his surveys and report) is Trinity High Water Mark, **as established by Act of Parliament in 1800** and which is on a level with the lower edge of a stone let into the outer wing wall of the lower side of the Hermitage Entrance to London Docks, having an inscription on it."

"The cast-iron plates having the City Arms, thus, (Sketch) on them, placed on the Bridges and various wharves, are the points of reference to which the Datum line of each section (of the survey) is made. By levelling from the nearest Ordnance Bench Marks to the Trinity High Water, the heights above Mean Water, Liverpool (that is Ordnance Datum) are found to be as shewn in the following table:—

Putney Toll House, Ordnance T.H.W. 1800...	+12.39 feet
Cadogan Pier	+12.18 ,,
Penitentiary Stairs	+12.31 ,,
Lambeth Palace	+12.35 ,,
Westminster Bridge	+12.30 ,,
Hungerford Bridge	+12.54 ,,
Waterloo Bridge	+12.47 ,,
Blackfriars Bridge	+12.21 ,,
Southwark Bridge	+12.26 ,,
Fishmonger's Wharf	+12.44 ,,
London Docks, Hermitage Entrance (Original mark)	+12.53 ,,

In August, 1857, the Thames Conservancy Act was passed, and in the first Section there is the following clause:—

"The **High Water** of Spring Tides at One Mile below London Bridge shall be taken as level with the mark fixed by the late Captain Huddart in the year One Thousand Eight Hundred, upon the Hermitage Entrance Lock to the London Docks, and transferred from thence to One of the Piers of the Bridges, commonly called "Trinity Standard"; the **Low Water** of Spring Tides shall be taken as **Eighteen Feet** below the level of the aforesaid mark at the same point; and the High and Low Water of Spring Tides at other places shall correspond with the above, allowing for the Difference of Flow and Ebb at each particular place."

The purpose of this clause is not easy to discern and it will be shewn in the following chapter that it is in practice inoperative.

High Tide—November, 1875.

In the Law Reports of the Chancery Division, 1878, there is a very interesting record of an extraordinarily high tide which reached 4-ft. 5-in. above Trinity High Water at the Entrance to Royal Victoria Dock and flooded the premises of an adjoining proprietor. It is relevant to this paper chiefly for the discrepancies in levels which were revealed in the evidence and for the mention of a 2-in. discrepancy which was probably the difference between 17-ft. 10-in. and 18-ft. already referred to.

The Defendants said their "Limit was 3-ft. 8-ins. above Trinity High Water."

The Plaintiffs said "They did not satisfy even that limit."
The Judge considered the liability to be 4-ft. 0-in.
The Appeal Court considered it to be 4-ft. 2-ins.
The Tide rose to a height of 4-ft. 5-in.

Mr. Justice Fry said "I cannot tell what the effect of the water was before the tide reached four feet except that I do know that it is in the nature of running water to make a way for itself and beginning therefore to flow it would cut its own channel and keep that channel open as long as there was any supply of water. .....Negligence is brought home to the Defendants for keeping wall a few inches low, although amount is not ascertainable."

Captain T. H. Tizard—1891.

In 1891 Her Majesty's Stationery Office published "Notes on the Tidal Datums and Levels of the River Thames and Estuary" compiled by Captain Tizard of H.M.S. "Triton." These notes contain some valuable tidal information but unfortunately it is not possible to avoid the conclusion that, in common with all

†Paper submitted to the Institution of Civil Engineers and published in abstract in the Journal of the Institution. Reproduced by permission.

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Tidal Levels of the Thames—continued

tidal records of last century, the results are most adversely affected by the uncertainty as to the value of Trinity High Water Mark and by the errors apparent in the Ordnance Bench Marks.

(1) Captain Tizard made the extraordinary statement (p. 3) that "By Act of Parliament 1800, Trinity high water was established as 12.53-ft. above Ordnance datum." As has already been shewn Trinity High Water was not set up by Act of Parliament and Ordnance Datum was not established until 1840—60.

(2) In referring to Captain Lloyd's North Standard at Sheerness he says:— "This standard mark was said to be 14.58-ft. above the Ordnance datum (or mean water level at Liverpool) by the late Captain Burstal. From my observations to Ordnance bench marks it is 14.42-ft. above Ordnance datum."

In 1849 the Metropolitan Sewers Board gave the value of 14.628-ft. to this mark and it may therefore be presumed to have sunk considerably since 1831. Making allowance for subsidence and for the general difference in North Kent between Ordnance and Newlyn Datum an approximate value may be estimated as 13.50-ft. above Newlyn Datum. It is not possible within the scope of this paper to attempt a closer estimate.

(3) At Tilbury Docks the depth of the Entrance Lock (lower lock and outer gates) is given variously as 43.50-ft., 43.53-ft. and 43.87-ft. below Trinity High Water. The published charts of the Authority give this figure as 44-ft.

The tide gauge of the Thames Conservancy (1891) at Gravesend is stated to be "0.2-ft. below what it is supposed to be."

(4) On Erith Pier the Trinity High Water Mark of the Thames Conservancy tide gauge is shewn to be 0.3-ft. lower than its correct level, by referring to a bench mark at "Wheatley Arms Tavern."

This bench mark is now given as 51.04-ft. above Newlyn Datum and Trinity High Water mark on the tide gauge must then have been at a level equivalent to 11.14-ft. above Newlyn Datum.

(5) At Blackfriars bridge the level of the Trinity High Water Mark is given as 12-ft. 2½-in. above Ordnance Datum.

(6) Captain Tizard has given a list of the levels of survey datum lines in reference to the sills of various dock entrances and presumably these were used for survey purposes thereafter.

But unfortunately it was assumed that all the Trinity High Water marks were at the correct level of 12.53-ft. above Ordnance Datum, an assumption so far wrong that all results depending upon it must be received with caution. The same caution must be exercised when dealing with any tidal figures published at this time and the true level of the zero must always be ascertained when comparing those results with present day figures.

(7) The following list of datum levels for use in surveying the river was given by Captain Tizard. The writer has placed alongside each level the approximate correction recently published by the Ordnance Survey.

It will be observed that these revised levels are sufficiently near to the figure 10.0-ft. to admit of the latter figure being considered as a useful working datum, down to Tilbury.

Place	Below O.D.	Correction	Below N.D.
Sheerness	7.00	1.5	8.50
Tilbury Dock	7.83	1.4	9.23
Erith	8.76	1.0	9.76
Albert Dock Entrance	8.83	1.1	9.93
Victoria Dock Entrance	8.64	1.4	10.04
Blackwall Entrances	8.50	1.3	9.80
Shadwell Entrance	8.23	1.4	9.63
Wapping Entrance	8.22	1.4	9.62
Hermitage Entrance	8.20	1.4	9.60
St. Katherine Dock	8.20	1.4	9.60
Blackfriars Bridge	8.15	1.3	9.45

Second Thames Conservancy Act—1894.

In 1894 another Conservancy Act was passed and the section relating to Trinity High Water was altered by omitting all reference to Low Tide and an Eighteen Feet Tide, and by describing High Water as "Ordinary" Spring Tide.

The section (187) read as follows:—

"The high water of ordinary spring tides at one mile below London Bridge shall be taken as level with the mark fixed by the late Captain Huddart in the year one Thousand eight hundred upon the Hermitage Entrance Lock to the London Docks, commonly called "Trinity Standard." The high water of ordinary spring tides at other places shall correspond with the above allowing for the difference of flow at each particular place."

Lower Thames Navigation Commission 1894—1896.

The Conservancy Act of 1894 required the appointment of a Commission to enquire into the dredging and other questions relating to the lower reaches of the River. The Commissioners, Sir John Wolfe Barry, Sir George Nares and Mr. George F. Lyster reported in 1896. In their Report it is stated:—

"having ascertained that no part of the Thames had been surveyed since 1883 we.....arranged with the assistance of the Admiralty and the Thames Conservancy, for a new survey to be made."

This was carried out by Commanders Jarrad and Pirie for the Admiralty and by Mr. Mostyn for the Conservancy and was the beginning of a much more intensive survey of the entire course of the River than had been previously attempted.

The surveyors used Trinity High Water as a datum with a Low Water Datum 20-ft. lower, to which all soundings were reduced, in the Sea Reach and at Gravesend and Woolwich, Trinity High Water having the value 12.50-ft. above Ordnance Datum.

Port of London Authority 1909

The Port of London Act of 1908 contained a reference to Trinity High Water, and the Port of London (Consolidation) Act of 1920 repeated it as follows:—

"Section 309. The high water of ordinary spring tides at one mile below London Bridge shall be taken as level with the mark fixed by the late Captain Huddart in the year one thousand eight hundred upon the Hermitage entrance lock to the London Docks, commonly called Trinity Standard. The high water of ordinary spring tides at other places shall correspond with the above allowing for the difference of flow at each particular place."

(1) The ostensible purpose of this section is clearly, as noted in the margin, to "fix High Water of Ordinary Spring Tide," presumably as some sort of protection in case of a conflict of interests. Yet there is no suggestion in any other part of the Act, that the Authority's interest is related in any way whatever either in level or line to High Water of Ordinary Spring Tides. If by some other Act or by some Court decision the Authority is indeed concerned in this particular level, the point has apparently not yet arisen.

(2) To fix an average level of a tide is (apart from erosion, etc.) equivalent to fixing an average line of that tide upon the foreshore, but the "fixing" of a line of average tide on the line which it occupied a century ago is contrary to the general rule that the line of the high water of **ordinary tides,** which forms the upper boundary of the foreshore, is a variable line through the process of nature and the passage of time, and the foreshore itself is termed a variable freehold.

It would not be consistent that the line of **ordinary** tides should be "variable" while the line of spring tides should remain a "fixed" line.

(3) The so called "fixing" applies to only one point in a river seventy miles long.

The reference to finding the level at "other places" by applying a "difference of flow" is impracticable and indeed without meaning. The reverse procedure must be adopted for it is necessary first to find the level at "other places" in order to determine the "difference of flow."

(4) Lack of point in this section is emphasised by the fact that both the Admiralty and the Authority publish figures to show that the high water of ordinary spring tide is not fixed at T.H.W. but is about 1-ft. above Captain Huddart's Mark at Hermitage

Tidal Levels of the Thames—continued

Entrance, 3-ft. above it at Richmond and about 2-ft. **below** it at Southend.

(5) It would appear that, although not the ostensible one, the real reason for the insertion of this section was to mention and indirectly to define, Trinity High Water.

In 1857 when the section was first drawn and inserted in the Thames Conservancy Act it was generally assumed that Captain Huddart's Mark had some legislative authority behind it as a datum for all levels throughout the Port. Commander Burstal in his report, already mentioned, gave expression to this view and it is not surprising that it resulted in some reference to it in the Act. But it is surprising that in 1920, seventy years after the establishment of the Ordnance Datum and the disclosure of the inaccuracies of all Trinity Marks such a reference should be continued. No surveyor nor engineer would seek for the level of Trinity High Water at Hermitage Mark or any other T.H.W. mark. He would obtain it locally by reference to an Ordnance Bench Mark and by estimating it as 12½-ft. above Ordnance Datum.

The reference to Trinity Standard is extremely vague in that it is not stated whether it is at the level of Captain Huddart's Mark in 1800, when it was erected, or in 1820 when it was transferred to several other places, or in 1848 when it was said to be 12-ft. 6⅜-in. above Ordnance Datum or at the date of the passing of the various Acts. The level of the stone at each date must differ considerably owing to the settlement, throughout that long period of time, of the dock wall on which the "Mark" was placed. The " Mark " cannot now be said to define T.H.W.

Further Sections of the Act

Section 197 of the 1920 Act is important as it defines the shore of the River Thames.

"The word "shore" means the shores of the Thames so far as the tide flows and reflows between high and low water marks at ordinary tides." It should be noted that the present tense "flows and reflows" precludes entirely the idea of fixing this line as it was in some earlier year.

An ordinary tide is not defined but is understood to be one that occurs four days out of seven and for practical purposes it may be assumed as an average for all tides over a long period. At any given place it must be ascertained by direct observation, without reference to any tides at Hermitage, if accuracy is desired. In any matter arising from this section accuracy is essential as the line of high water ordinary tides forms an important limit to the jurisdiction, in certain respects, of the Port of London Authority.

Section 216 requires the Authority "to form a channel between the Nore and Gravesend not less than thirty feet deep at low water of ordinary spring tides....."

In this case also direct observation only is required and no reference to any tide at Hermitage is necessary.

(a) Section 222 protects the Bridge of the West London Extension Railway (now known as Battersea Railway Bridge) from dredging deeper than a level 30-ft. below Trinity High Water mark.

(b) Section 225 refers to a "maximum depth below Trinity High Water Mark" to which certain works may be carried.

(c) Part of Section 27 in the Fourth Schedule requires a clear headway under Woolwich Manor Way Bridge of 14-ft. above Trinity High Water mark.

In these three sections Trinity High Water is referred to solely as a datum, presumably of a known value which, however, is not stated, and in practice the levels of the various works or dredging would be settled by reference to local bench marks of the Ordnance Survey by assuming Trinity High Water as 12.50-ft. or 12.53-ft. above Ordnance Datum. It would be much more satisfactory to have these limits defined in the Act with reference to Ordnance Datum instead of Trinity High Water.

Highest Known Tide (January, 1928)

On 6th—7th January, 1928, there occurred a disastrous tide which exceeded all previously recorded high tides.

A Report was published in March, 1928, by the Minister of Health and should be consulted for a list of all the previous high tides recorded by various authorities.

As a result of the investigations following this tide, the London County Council revised the levels to which riparian owners were required to raise the flood walls and these levels were given (in March, 1933) as heights above Newlyn Datum instead of, as formerly, above Trinity High Water. But certain other local authorities have not yet revised their regulations.

Surveys by the Port of London Authority.

The Port of London Authority is required by their 1920 Act to survey the river and publish charts. The results of their survey work are also available on charts published by the Admiralty.

These contain a great deal of valuable information on tidal matters and show the system of datum levels now in use. It is only necessary to summarise a few of the relevant figures.

In all these charts Trinity High Water is the principal reference datum, and is stated to be 12.53-ft. above Ordnance Datum. Low water datum to which all soundings are referred is given as a depth below Trinity High Water and also below Ordnance Datum, and is stated to be "about 1-ft. below the level of Mean Low Water Springs."

At Richmond, Low Water Datum is 12-ft. 6-in. below Trinity High Water and it varies from thence to London Bridge by steps of 6-in.—9-in.

Below London Bridge it varied (at date 1931) as follows:—

	Below T.H.W. ft.	in.
From London Bridge to Deptford, 4 miles	21	0
Deptford to Broadness, 19 miles	21	3
Broads to Mucking Light, 10 miles	21	0
Mucking Light to Shellhaven, 2 miles	20	9
Shellhaven to Thorney Creek, 3 miles	20	6
Thorney Creek to Crow Stone...	20	3
Crow Stone to West Shoebury Buoy	20	0
West to Mid Shoebury Buoy	19	9
Mid Shoebury Buoy to the Seaward Limit	19	6

Recent Admiralty Charts give the mean high water of spring tides as follows:—

Richmond	3¼ feet **above**	Trinity High Water
London Bridge ...	1¼ feet **above**	do.
Tilbury Dock ...	¾ feet **below**	do.
Southend	1¼ feet **below**	do.

The Second Geodetic Levelling of England and Wales. 1912—1921.

During the years 1840—1860 as already mentioned the Ordnance Survey Department undertook a complete survey of the levels of England and Wales and recorded these levels on their recently published maps, the datum used throughout being the assumed mean sea level at Liverpool.

A revision of these levels was commenced in 1894 and again in 1904 but it was then found that "the old primary lines of levelling no longer fulfilled their purpose and that unless the country had tilted downward from north-west to south-east in the previous 70 years, there must have been errors as large as 21-in. in the earlier work in Essex and Kent."

It was, therefore, decided in 1911 to commence an entirely new survey conducted on much more precise methods of observation and calculation. After extensive tidal observations at Dunbar, Felixstowe and Newlyn (Cornwall) the mean sea level at Newlyn was selected as the datum to which all levels were referred.

The country was covered with an entirely new network of primary levels having fundamental bench marks of a permanent character and on rock foundation. From these marks, placed about 30 miles apart, subsidiary lines were then made and the usual bench marks cut on buildings and other places.

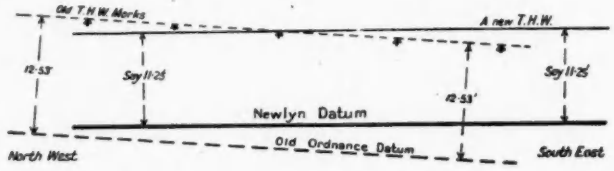
London, on account of the geological formation of the Thames Valley has no fundamental bench mark nearer than Croydon in Surrey and Snodland in Kent.

A report on all these operations was published by the Director-General in 1922 but the values of bench marks in the London area have only been made available since 1932.

Tidal Levels of the Thames—continued

Divergent Datum Planes

The relevant feature of the new datum of the Ordnance Survey, which for convenience may be called Newlyn Datum, is that it is in effect, not parallel to the older datum and therefore the height of Trinity High Water above the old Ordnance Datum (12.53-ft.) cannot be expressed universally as a given height above Newlyn Datum.



The old and new datum planes are together at Liverpool but diverge as they go eastward and southward. In the Midlands the new plane is about 6-in. above the old plane, at Windsor 12-in. above, at Southend 18-in. above and at Felixstowe 21-in. above.

If, therefore, Trinity High Water were given a new value it may be correct at one place, several inches too low at Teddington and several inches too high at Southend, when compared with the old marks.

A further complication arises from the local variations, either subsidences or errors, which result in the divergency of planes not being uniform. For example the general difference near Teddington is 1.2-ft., at Southend and Warden Point about 1.5-ft. while at Gravesend and Erith the difference is only 1.0-ft.

Also while at Gravesend the difference is 1.0-ft., on the marshes at Tilbury or Thurrock on the opposite bank of the river the difference is about 1.4-ft.

In these circumstances it is clearly impossible that the existing line of Trinity High Water Marks can be a uniform height, above Newlyn Datum.

As the old and new ordnance datums are not parallel to each other it follows that, if a value is selected for the height at Hermitage, it would be necessary, if the old and new Trinity High Waters are to coincide with each other, to give a higher value at Teddington and a lower value at Southend.

But if a height is selected as the height everywhere along the river, there is set up at once a new Trinity High Water, perhaps coinciding at Hermitage with the old Trinity High Water, but lower by several inches at Teddington and higher by several inches at Southend, than the old Trinity High Water.

Confusion would inevitably, and for many years, result from an announcement that Trinity High Water is exactly 11¼-ft. (or any other figure) above Newlyn Datum.

One example illustrating still further the difficulties involved in establishing a new Trinity High Water, is the case of the well known tide gauge at Southend Pier. For many years this gauge has been one of the most important recording tide gauges on the river, and the London County Council use it to give the people of London warning of the danger of flooding. When the tide at this gauge rises to a level above the T.H.W. mark there is immediately set in motion the great protective organization of the London County Council.

The writer submits that much needless complexity and risk of error at Southend and at other places, would result from the introduction of a New Trinity High Water.

In the following section he proposes to shew how all risk of confusion may be averted by the establishment of a new official low water datum and by reserving Trinity High Water for purely local dock purposes.

On Datums Generally.

The choice of a datum for hydrographic purposes is at least partly arbitrary. Commander Warburg in his standard book on tides, describes such a datum as a level "below which the tides seldom fall," but which ought to be considered as "an arbitrary level." At the International Hydrographic Conference, 1926, it was agreed that "chart datum.....should be a plane so low that the tide will but seldom fall below it."

From British Admiralty publications it may be seen that this international datum has not yet been fully adopted and "widely different datums remain in use."

For example, around the British Isles the datums are below the mean low water of spring tides, by varying distances, as follows:—

Dover	...	...	...	½-in.
Portsmouth	...	...	...	2-in.
Harwich	...	...	...	12½-in.
Invergordon	...	...	...	23-in.

At Heligoland the German Admiralty has fixed the Datum at the same level as Mean Low Water Springs,: while at Brest the French Admiralty has adopted a level 4½-ft. lower. These variations may not be an evidence of entire arbitrariness but they do serve to shew that a low water datum is largely arbitrary.

But the outstanding consideration from the point of view of the navigator is that a datum should be chosen so low that, in the words of the Admiralty, the depths or soundings given on a chart will show **"very approximately"** the least depths to be expected.

The writer makes no criticism of the Low Water Datums in use on the river Thames on the grounds of not conforming to Admiralty standards, or of having inaccuracies as proved by the recent re-levelling, but he considers that the existing system has grown up on the rather **narrow ground of hydrographic work only** and that due consideration has not been given to the requirements of engineers and others. Some bias towards purely hydrographic and navigation practice would be expected from the distinguished naval officers who have guided such matters on the river for the past century.

For example, the many engineers who design and build the flood defences along the 70 miles of the River under the jurisdiction of the Authoriy, must constantly relate tides to the levels of defences, but that relation is obscure and cannot readily be found in the usual tide tables.

The existing Low Water Datums could be reduced in number, they could be simplified by eliminating very small fractions of measurement, and the relation between Newlyn Datum and the tide, actual or predicted, on any given date, could be made readily ascertainable. The suggested London Zero Tide, exactly 10-ft. below Newlyn Datum would form a Low Water Datum equally suitable for all purposes, navigational, surveying or engineering, and it conforms admirably to the criterion for a hydrographic datum.

(To be continued)

Stockholm Free Port Company.

The directors of the Stockholm Free Port Company have appointed Mr. Hjalmar Malmström, hitherto deputy managing director of the company, to be managing director in succession to the late Mr. Sal. Vinberg. In a statement on the future plans for the undertaking, Mr. Malmström said that "the greatly increased amount of warehousing done in the Free Port had resulted in a substantial increase in income, and for 1943 this item was likely to amount to about 1½ million kroner, compared with 1,270,000k. in 1942 and an average of 900,000k. in each of the three pre-war years. This had involved great pressure on the company's warehousing facilities, which had been used to capacity. The most urgent need after the war would be to extend the cold storage facilities. It had so far been possible to do little in the way of extensions and modernisation. Work recently authorised by the City Council would result in an increase in storage space of about 1,500 square metres. Cranes and railway tracks had been modernised. Plans were under discussion for the extension of the quays by 100 metres, with the necessary quays and railway tracks, involving a cost of some 2,000,000k., and new buildings estimated to cost about 4,000,000k. were projected.

The Design of Piled Structures

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Introduction.

The amount of new work and of repair and reconstruction work to be expected after the war will, no doubt, involve the design of a considerable number of piled structures, and, in the writer's opinion, the problem presented by such design is not fully understood by many designers, particularly in the case of structures comprising inclined or raking piles.

When the designer has calculated the load from the superstructure on the piles carrying this, his problem is twofold, viz. :—

(a) What is the carrying capacity of a pile, under the conditions obtaining ?

and

(b) How is the load from the superstructure distributed over the piles ?

The first question has been given a considerable amount of thought, frequently being the subject of discussion in technical periodicals, and a great number of formulæ have been developed for the determination of the carrying capacity of a pile not driven to refusal. The subject will be dealt with herein, summarising what now may be considered good practice.

The question of how the load from the superstructure is distributed over the piles is simple as long as the piles are all parallel and parallel to the load from the superstructure. It becomes more complex when a pile-group contains raking piles which, in addition, may be raking at different angles and in vertical planes which are not parallel. Certain methods are in use for the design of the simpler forms of such pile-groups, but the method which shall be described herein has proved them to be rather inaccurate and furthermore not always economical, as will be illustrated by examples later. The writer has not been able to find in any English text book any description of the design of pile-groups containing vertical and raking piles. The " methods in use " referred to are such as the writer has seen applied in actual designs.

The more accurate method which is described herein, and which may be termed " the elastic method," has been developed by Scandinavian engineers and, in particular, by Prof. Nokkentved at the Royal Technical College, Copenhagen.

The design of the piles for a piled structure proceeds in the following order :—

1. Selection of pile material.
2. Determination of approximate pile length.
3. Selection of pile section.
4. Determination of the carrying capacity per pile.
5. Determination of the approximate total number of piles required.
6. Distribution of the piles.
7. Calculation of the loads on the individual piles and redistribution and addition or omission of piles if required.

The above outline of design applies to the general case, and it is obvious that, in the case of vertical piles subject to vertical loads only, the correct number and distribution of the piles are determined directly and item 7 is not required.

Selection of pile material.

The material for the piles may be either timber, steel or reinforced concrete.

The main consideration in selecting the material is economy, and both initial expense and life have to be taken into account. In the case of fender work, it is of course not the economy that is the main consideration, but such piles are outside the scope of this treatise.

The application of timber should be limited to temporary tructures and to permanent structures where the conditions are uch that the timber will not deteriorate and the piles have a horter life than the remaining part of the structure.

The conditions under which timber can be used or cannot be used are too well known to be repeated here.

The application of steel for piles is generally restricted to sheet piles and very long bearing piles of a box section. The life of steel piles, particularly when made from special steel, is sufficient for many classes of work as it is up to over 100 years, even in sea water.

Reinforced concrete is the most modern of the materials used for piles and has, in fact, revolutionised and extended the application of piles for foundations, harbour works, etc. The proportioning of the concrete used for piles is now generally 1 part of Portland cement to $1\frac{1}{2}$ parts of fine aggregate, to 3 parts of coarse aggregate. For piles exposed to sea water it is of course necessary to take the same precaution as with other concrete exposed to sea water, and the use of Trazz-cement or other special cement is to be recommended. Concrete made with high-aluminous cement is also very highly resistant to attack by sea water and by certain chemicals which may be present in the ground ; but high-aluminous cement concrete needs extremely careful curing and appears more fragile than Portland cement concrete.

The types of piled structures, the local conditions and the material prices are so varied that no definite rules can be given for the selection of the most suitable material for the piles, and each case must be treated on its own merits.

Determination of approximate pile length.

The determination of the approximate pile length is a matter of considerable importance, but the amount of money that can be spent on finding the approximate length depends, of course, upon the extent of the work.

If a small number of piles only have to be driven, the designer is generally restricted to fix the pile length on the basis of his general knowledge of local conditions, e.g., length of piles driven for other structures in the vicinity or known properties of the subsoil. This question is dealt with further at the end of the section on the determination of the carrying capacity of piles.

In the case of structures involving a large number of piles, the approximate pile length is generally determined by borings giving information in regard to the nature of the subsoil or by the driving of trial piles. The latter may either be piles of the same type as those to be applied in the structure, or they may be special " piles," as those driven by the Pre-piling Surveys Limited.

In the case in which the pile length is determined from borings, it is fixed by experience gained from piles driven in similar subsoils, in conjunction with the use of the formula quoted at the end of the section on the carrying capacity of piles.

Trial piles are driven to a certain calculated set, as explained later, but for real important foundations, the carrying capacity assumed corresponding to the set should be checked by a trial loading of $1\frac{1}{2}$ times the working load, and this load should be applied for at least one week.

The use of the special trial piles is described by Mr. G. B. R. Pimm, M.Inst.C.E., in *The Structural Engineer* for July, 1938.

Selection of pile section.

The pile section depends on the load, the driving conditions and the length of the piles.

A suitable section corresponding to driving conditions and length of pile is generally selected, and the number of piles in each pile-group is thereafter determined from the load it has to carry, and the carrying capacity per pile.

For long piles, say, from 40 ft. and upwards, it will generally be the most economical to select the least possible section determined by the length and driving conditions.

For shorter piles, it may pay to select a larger section than that thus determined, in order to reduce the number of piles per pile-group and thereby reduce the driving cost and also the dimensions of the pile caps.

Design of Piled Structures—continued

In order to utilise the carrying capacity of the piles to the fullest extent, it may pay to select two or more sections. This may be the case where piles are to support a series of column footings with greatly varying loads.

Carrying capacity of piles.

The carrying capacity of a pile depends upon :—

(a) The section and length of the pile and the material of which it is made.

(b) The nature of the ground into which it is driven.

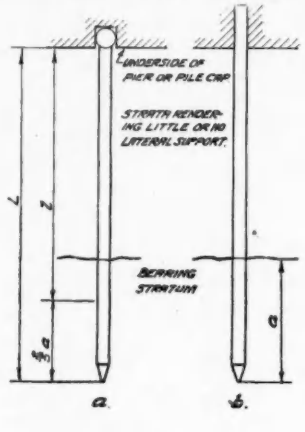


FIG. 1.

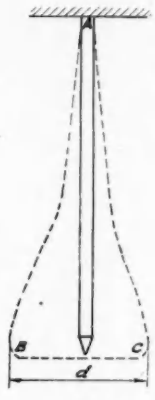


FIG. 2.

The upper limit for the load a pile will carry is the load a column of the same material, section and effective length would carry. The effective or free length of the pile depends upon the degree to which the ends of the pile are restrained. The various degrees of restraint are shown on Fig. 1, and the following cases are to be considered :—

Case I (Fig. 1a) : Completely restrained at a distance L—1 from the point ; but no restraint at the underside of the foundation. Horizontal movement at underside of foundation prevented.

Case II (Fig. 1b) : Completely restrained at a distance L—1 from the point and at the underside of the foundation. Horizontal movement at underside of foundation prevented.

Case III : As Case I, but horizontal movement at underside of foundation not prevented.

Case IV : As Case II, but horizontal movement at underside of foundation not prevented.

Cases II or IV are generally obtainable for reinforced concrete piles, whereas it will be more correct to assume Cases I or III for timber or steel piles projecting slightly only into the foundations.

The effective lengths to be used in the column formula are :—

Case I $l_e = 0.71 \times l$
Case II $l_e = 0.50 \times l$
Case III $l_e = 2.00 \times l$
Case IV $l_e = l$

The length, l, is dependent upon the nature of the soil into which the pile is driven, and is accordingly a matter of judgment. The general case is that the pile is partly in the air, partly in water and partly driven through soft ground into a firmer stratum giving the necessary resistance to the pile's further penetration. In determining l, it will be safe to disregard resistance to side movement from the soft ground, and fix L—1 as $\frac{2}{3}$ of the depth the pile is driven into the firm stratum.

The condition where the pile is driven to rock through mud or other material giving little or no lateral support is also conceivable. In this case there would be no restraint at the bottom of the pile, whereas the condition of restraint at the top would be as before, and the effective lengths of the pile would be :—

Case I $l_e = L$ (L = length of pile)
Case II $l_e = 0.71 \times L$
Case III $l_e = 2.82 \times L$
Case IV $l_e = 1.41 \times L$

The maximum carrying capacity of a pile can now be determined on the basis of the above and the general rules for the design of columns. Whether it is possible to utilise the pile to this extent depends upon the following conditions :—

(1) The pile has to be strong enough to withstand the stresses it becomes exposed to during the processes of transporting, pitching and driving ; and for long piles these stresses may easily exceed the stresses caused by the load on the pile in its final position.

(2) The resistance to penetration of the ground into which the pile is driven.

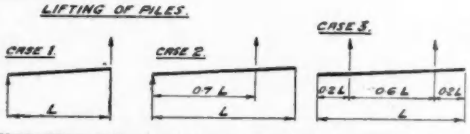
In regard to the fulfilment of the first of these conditions, it is necessary, firstly, to determine the pile section in such a manner

TABLE I.

REINFORCED CONCRETE PILES.

CONCRETE 1 : 1½ : 3
f_c = 1100 lb PER SQ. INCH (BENDING)
880 " " " (DIRECT COMPRESSION)
f_s = 18000 " " " (TENSION)
PILE ACTING AS COLUMN MAX. LOAD =
$P_{MAX.} = (f_c + 15 \cdot f_s) \times 0.39$ TONS

LIFTING OF PILES.



SECTION	LONGITUDINAL REINFORCEMENT	MAXIMUM LOAD	MAXIMUM LENGTH CASE 1	CASE 2	CASE 3
10"×10"	4 No. ⅝" DIA.	46 TON.	23'-0"	38'-6"	51'-6"
	4 " ¾" "	49 "	27'-0"	45'-0"	60'-6"
	4 " ⅞" "	53 "	32'-0"	53'-0"	71'-6"
11"×11"	4 " ¾" "	57 "	26'-6"	44'-0"	59'-0"
	4 " ⅞" "	61 "	30'-6"	50'-6"	68'-0"
	4 " 1" "	65 "	35'-0"	58'-0"	78'-0"
12"×12"	4 " ⅞" "	66 "	24'-6"	40'-6"	54'-6"
	4 " 1" "	70 "	28'-6"	47'-6"	63'-6"
	4 " 1⅛" "	74 "	32'-0"	53'-0"	71'-6"
13"×13"	4 " ⅞" "	76 "	23'-6"	39'-0"	52'-6"
	4 " 1" "	80 "	27'-6"	45'-6"	61'-6"
	4 " 1⅛" "	84 "	31'-0"	51'-6"	69'-0"
14"×14"	4 " 1" "	90 "	26'-0"	43'-0"	58'-0"
	4 " 1⅛" "	94 "	31'-0"	51'-6"	69'-0"
	4 " 1¼" "	99 "	35'-0"	58'-0"	78'-0"
15"×15"	4 " 1" "	106 "	30'-0"	50'-0"	67'-0"
	4 " 1⅛" "	111 "	33'-6"	55'-6"	75'-0"
	4 " 1¼" "	116 "	37'-6"	62'-0"	84'-0"

SECTION	LONGITUDINAL REINFORCEMENT	MAXIMUM LOAD	MAXIMUM LENGTH CASE 1.	CASE 2.	CASE 3.
16"×16"	4 No. 1" DIA.	118 TON.	29'-6"	49'-0"	65'-6"
	4 " 1⅛" "	123 "	33'-0"	55'-0"	74'-0"
	4 " 1¼" "	128 "	36'-0"	60'-0"	80'-6"
	4 " 1⅜" "	134 "	39'-6"	66'-0"	88'-0"
	8 " ⅞" "	120 "	27'-6"	45'-6"	61'-6"
	8 " 1" "	128 "	32'-6"	54'-0"	72'-6"
18"×18"	4 " 1⅛" "	150 "	31'-0"	51'-6"	69'-0"
	4 " 1¼" "	155 "	34'-0"	56'-6"	76'-0"
	4 " 1⅜" "	161 "	37'-6"	62'-6"	84'-0"
	4 " 1½" "	167 "	41'-0"	68'-0"	91'-6"
	8 " ⅞" "	154 "	29'-6"	49'-0"	66'-6"
	8 " 1" "	163 "	33'-6"	55'-6"	75'-0"

REDUCTION IN MAX. LOAD DUE TO SLENDERNESS
$P = C \times P_{MAX.}$ S = SIDE LINE OF PILE
l = EFFECTIVE LENGTH OF PILE ACTING AS COLUMN

l/s	15	18	21	24	27	30	33	36	39	42	45
C	1·0	0·9	0·8	0·7	0·6	0·5	0·4	0·3	0·2	0·1	0

PILE LENGTHS SHOWN TO THE RIGHT OF THE HEAVY LINE WOULD NOT NORMALLY BE USED.

Design of Piled Structures—continued

that it is strong enough to resist the bending stresses set up during the transport and pitching and, secondly, to consider the stresses in the pile, mainly in the head and near the point, during the process of driving the pile.

In Table 1 are given maximum loads and maximum lengths for reinforced concrete piles of the most commonly used sections.

In order to form an opinion of the resistance to penetration, i.e., the load carrying capacity of a given sub-soil, a great number of experiments have been carried out and a number of formulæ have been developed, partly on the basis of these experiments and partly through theoretical considerations. Common for all the formulæ is that the carrying capacity of a pile is calculated as a function of the weight of the hammer with which the pile is driven and of the penetration or set of the pile per blow of the hammer.

The resistance to the penetration of the pile is caused

(1) by the direct resistance at the point of the pile ;

(2) by the friction along the sides of the pile.

When the resistance to the penetration of the pile is practically totally due to the former of these causes, the pile is referred to as " a pile driven to firm bottom " or " to refusal " ; this is, e.g., the case with a pile driven through mud or fill to rock. If, on the other hand, the toe resistance is very small, the pile is referred to as " a friction pile," e.g., a pile driven in a uniform soil, such as deposits of silt or clay.

The formulæ for the calculation of the carrying capacity of a pile are obviously not applicable to piles driven to firm bottom, but are used with greater or lesser accuracy in all other cases. Below are given a number of formulæ in which the following notations are used :—

R =ultimate resistance overcome in driving.
=ultimate load on pile (in tons).
W=weight of hammer (in tons).
P =weight of pile (in tons).
h =free fall of hammer (in inches).
s =set or penetration of pile per blow (in inches).
c =temporary compression of pile and cap or dolly (in inches).
y =a coefficient of efficiency.
f =section of pile (in square inches).
L =length of pile (in inches).
F =factor of safety.
S =safe load on pile (in tons).

Common for all formulæ is $S=\frac{1}{F\times R}$, but, as indicated below, various factors of safety are used in connection with the various formulæ.

1. Eytelwein $R=\frac{W^2}{W+P}\times\frac{h}{s}+W+P$ F=4—5

2. Brix $R=\frac{W^2 P}{(W+P)^2}\times\frac{h}{s}$ F=2

3. Wellington (1888) Engineering News $R=\frac{Wh}{s+1}$ F=6

4. Goodrich (1902) $R=\frac{0.276\ W\ h}{s}$ F=4—5

5. Rankine $R=\frac{-2\ Efs}{L}+\sqrt{\frac{4\ W\times h\times Ef}{L}+\left(\frac{2\ Efs}{L}\right)^2}$
E=Modulus of elasticity in ton per sq. in.
F=4—5

6. Hiley (1922) $R=y\times\frac{W\times h}{s+\frac{c}{2}}+W+P$ F=3—4

7. Rausch (1930) $R=\frac{W^2}{W+P}\times\frac{h}{s+\frac{c}{2}}$ F=3

Values for y and c and further directions for the use of Hiley's formula can be found in the B.S.P. Handbook (1940).

The applicability of the formulæ is limited to values of W between 0.5 and 3 times P.

A comparison of the results obtained from the formulæ is most easily arrived at by applying them to a few examples.

Such application shows a very great variation in the results, and as none of the formulæ is based on assumptions indisputably correct, a given formula should only be applied to piles driven under conditions where previous experience has proved that it will give satisfactory results ; and the factor of safety should be fixed in each individual case.

It is the writer's experience that, for reinforced concrete piles, satisfactory results are obtained under most conditions by using Eytelwein's formula—also called the Dutch formula—with a factor of safety of 4 and for sets not less than $\frac{1}{8}$" per blow as an average for 10 blows.

Care should be taken in using Eytelwein's, or any formula, in certain clays and under certain conditions in regard to water. The carrying capacity of a pile driven in a uniform bed of clay depends almost entirely on the friction between the sides of the pile and the clay. If there is water over the clay, this water may find its way down between the clay and pile sides and greatly reduce the friction, thereby altering the conditions obtaining at the time the pile was driven and decreasing the carrying capacity of the pile. This is, of course, particularly likely to take place in the case of piles exposed to vibrations or horizontal forces, such as piles in jetties subject to impact from vessels, foundations for heavy machinery, railway bridges in curve, etc.

On the other hand, the friction frequently increases with time, the rapidly following blows having helped to decrease it during the driving. This fact is often observed if the driving is stopped at night and continued again the next morning. It may then require quite a number of blows to get the pile going down at the same rate as when work was stopped. Even an hour's stoppage for meals may have this effect.

In applying the formulæ it should be remembered that the fall, *h, is the free fall of the hammer*. This is very rarely the case in practice, as the hammer, when falling, is not released from the hoisting wire rope and thus has to draw the top sheave and the drum on the winch. If this is the case, the carrying capacity calculated is to be reduced by 20 per cent., and it should further be carefully observed that no additional resistance to the free fall is exerted, e.g., by a slight application of the brake or by similar means. In order to obtain the nearest approach to a free fall, a trigger arrangement releasing the hammer from the hoisting rope can be inserted and used for the final measurements of the set.

The set should preferably be measured by help of a level from some little distance. It is to be remembered that in driving the pile, a quantity of earth corresponding to the volume of the pile is displaced and this tends to raise the ground level ; also there are elastic movements and settlements of the frame, and, therefore, neither the ground in the immediate vicinity of the pile, nor the frame should be taken as fixed points for measuring the set.

Reverting to a comparison of the results obtained by using the various formulæ, it is obvious that for the formulæ 1, 2 and 4—where the value R is in inverse proportion to *s*—the range of applicability of the formulæ is restricted to values of *s* more than about $\frac{1}{8}$".

It is further apparent that the formulæ 3 and 4 give unreasonably small values of R for reinforced concrete piles. These two formulæ are also relatively old and were developed for timber piles.

A comprehensive discussion of the various factors of the pile-driving formulæ is found in Mr. Pimm's paper " Recent Developments in Deep Ground Testing," in the July, 1938, issue of the *Structural Engineer*. The writer agrees with Mr. Pimm in his conclusion that the " impact formulæ " are of little value if nothing is known of the sub-soil into which the piles are driven. But the mere fact that the piling has been found necessary, indicates that something is known ; and experience of the same or similar sub-soil justifies in many cases the use of a formula for determining the carrying capacity of a pile. It is, however, obvious that some considerable experience is necessary on the part of the engineer in selecting the formula and in fixing the factor of safety.

It is, of course, desirable to obtain knowledge of the sub-soil by borings or other means, but the extent of the piling work is very often so small that the expense of such borings, or other tests, is

Design of Piled Structures—continued

not warranted, and by fixing a high factor of safety, satisfactory results are usually obtained.

The length of the piles is generally determined by the driving of trial piles. The length of the trial piles must be fixed somewhat in excess of the length expected to suffice, and must be based on the available knowledge of the sub-soil or on records of piles driven in the vicinity.

It is the writer's opinion that for important foundations where no settlement can be tolerated or for foundations with a great number of piles, the carrying capacity of the piles, as calculated by a formula, should be checked by a trial loading of the trial piles of 1½ times the maximum working load, and this load should be applied for at least one week.

It should be remembered, in designing a pile-group, that *n* piles do not necessarily carry *n* times as much as one pile. The more the carrying capacity of the pile depends upon skin friction, the more important it is to have this in mind. Fig. 2 illustrates the manner in which a friction pile transfers the load to the ground below the toe of the pile. It is obvious that if the earth bodies A B C of the individual piles overlap, the carrying capacity is reduced accordingly.

It is also to be remembered that, in the final instance, the carrying capacity of a pile, or a pile group, depends upon the carrying capacity of the ground below the pile toe. In the case of a pile mainly supporting its load through toe resistance, this is obvious, but also for friction piles this is the case, as will be seen from Fig. 2. The friction pile has transferred its load to the earth body A B C, and it is apparent that equilibrium is not obtained until this body is of such extent that the intensity of the load on its underside equals the carrying capacity of the ground below.

The conditions obtaining in the case of a pile-group consisting of friction piles are illustrated by Fig. 3. It will be seen that, once a sufficient number of piles are provided to spread the load so that the intensity of load on the ground below the toes of the piles equals its carrying capacity, an increase in the number of piles will not increase the carrying capacity of the pile-group.

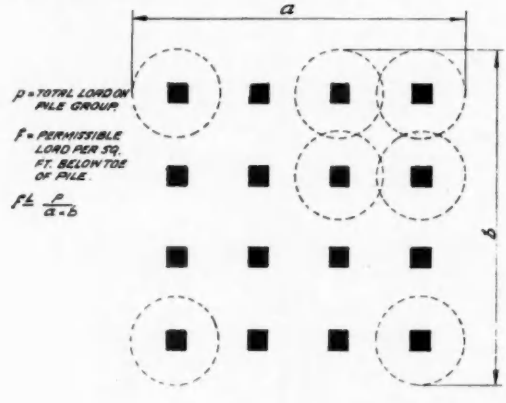


FIG. 3.

The minimum spacing from centre to centre of piles should in no case be less than 2½ times the side line of the pile, and its dependence on the permissible load on the ground below the toe of the pile is given in Table II, where

P = working loads on pile in ton

f = permissible load on ground in ton per sq. ft.

TABLE II.

f/P	20	30	40	50	60	70	80	90	100
2 ..	3′ 2″	3′ 11″	4′ 5″	5′ 0″					
3 ..	2′ 7″	3′ 2″	3′ 8″	4′ 1″	4′ 6″	4′ 10″			
4 ..	2′ 3″	2′ 9″	3′ 2″	3′ 6″	3′ 11″	4′ 2″	4′ 5″	4′ 9″	5′ 0″
5 ..		2′ 5″	2′ 10″	3′ 2″	3′ 6″	3′ 9″	4′ 0″	4′ 3″	4′ 6″
6 ..			2′ 6″	2′ 10″	3′ 2″	3′ 5″	3′ 8″	3′ 11″	4′ 1″

It is a common experience that the driving of the first piles in a pile-group is easier than the driving of the last, and that a given set is obtained at a lesser depth for the latter, or if they are driven to the same depth as the first driven, the set will be much smaller. This is obviously due to the compression of the ground by the driving of the first piles, but as this compression does not extend much below the toe of the piles, the carrying capacity of the group is not increased, although the application of a pile formula to the individual piles and an addition of the resulting values would show an increase.

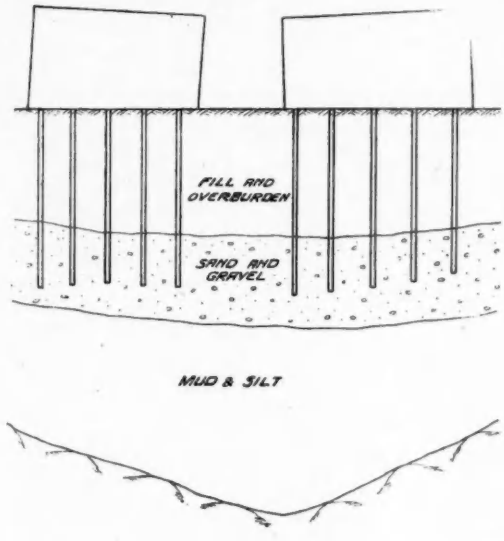


FIG. 4.

The preceding illustrates that the information required for the design of a piled structure is not obtained by the driving of trial piles only and the application of a formula to the results recorded. Much further consideration has to be given to the problem, and experience only can decide what additional investigation is required in each individual case.

The carrying capacity of a pile or a pile-group may also be influenced by strata well below the toe of the pile. Fig. 4 shows a case where a soft stratum at some depth may endanger a piled structure although all the piles have been driven to an apparently sufficient set according to any of the pile formulæ. The case illustrated has actually been observed by the writer, and the two structures leaned considerably towards each other as the deeper the soft stratum was, the more it had been compressed.

A similar occurrence may be caused by dewatering of a water-carrying stratum below the pile toe, and this should be borne in mind when designing piled foundations in localities where new water supply schemes may be carried out.

If the soft stratum is of uniform depth and the bearing stratum into which the piles are driven is of considerable thickness, it will generally be sufficient to stop the driving in this stratum and rely upon it to distribute the load over a greater area of the soft stratum. In the case where the geological formation of the surrounding land leads to a soft stratum being suspected, careful preliminary investigations should, however, be carried out. In this respect, considerable information can be obtained in Great Britain from the Geological Survey.

It has finally to be mentioned that, whereas the formulæ quoted previously are all based on the resistance of the pile to move under the impact from the hammer, other formulæ have been developed on the basis of the earth pressure theory. A recent formula by H. Doerr (1933) reads :—

$$S = w \times L \times a \times \tan^2\left(45 + \frac{\theta}{2}\right) + \tfrac{1}{2} \times c \times L^2 \times u \times (1 + \tan^2 \theta)$$

Design of Piled Structures—continued

where : S =safe load on pile in tons
w =weight of soil in tons per cu. ft.
L =embedded length of pile in ft.
a =sectional area of pile in sq. ft.
o =circumference of pile in ft.
θ =natural slope of soil
u =coefficient of friction between pile and soil.

The first factor in the formula is the toe resistance and the second factor is the skin friction. The formula is also written as :—

$$S=a\times f+c\times o\times L$$

where : f =permissible load on the ground at the toe in ton per sq. ft.
c =coefficient of skin friction in tons per sq. ft.

f is calculated from the equation $f=w\times L\times\tan^2\left(45+\frac{\theta}{2}\right)$ and

Terzaghi gives the following values for c :—

Plastic clay	0.20 tons per sq. ft.
Soft sandy clay	0.30 ,, ,,
Loosely settled sand	0.35 ,, ,,
Stiff clay	0.55 to 0.90 ,, ,,
Compact sandy clay or marl	0.75 ,, ,,
Compact clean sand	0.90 to 1.10 ,, ,,

The above-quoted formula is probably even more approximate than those previously mentioned, but may be used with advantage in preliminary designs for fixing length, cross section and number of piles to be included for in comparative estimates.

The question of the permissible pull in a pile may also arise in designing a piled structure. Failing any test, the formula

$$S=c\times o\times L$$

may be applied as a guidance and in preliminary designs. The values of c are as quoted above.

In the case of large and important structures, extraction trials should be carried out, as well as test loadings, before the structure is finally designed.

(*To be continued*)

Swedish Lighthouse Developments

Installation of Two New Lights

It is announced in the Swedish Press that two new lights are to be established this year in the Kalmarsund, between the island of Oland and the Swedish mainland. An AGA light, to be named Slottsbredan, of the white, red and green flashing type, is to be erected on the Slottsbredan shoal, N.W. of Borgholm; its power will be 1,000 c.p. for white, 250 c.p. for red and 125 c.p. for green. The second light, to be erected on Sillasen shoal, S.E. of Skaggenäs, and named Sillasen, will be of the electric type, its power being 16,000 c.p. for white, 4,000 c.p. for red and 2,000 c.p. for green. This lighthouse will also be fitted with a fog signal. Both light and fog signals will be operated from Skaggenäs pilot station.

In a recent lecture by the director of the Swedish Pilot Board it was stated that there are now 1,900 lighthouses, beacons, light-buoys and light-vessels installed along the Swedish coast. Of these 800 belong to the Pilot Board. During the war the Board has taken into use about 160 new lights—mostly sailing channel beacons with AGA lights. Among other things, a continuous system of beacon-lighted and sheltered navigation channels has been created along the Baltic coast from Oregrund in the Aland Sea to Kalmar Sound, and similar sailing routes have been provided along the northern part of the West Coast. About 540 of Sweden's 1,900 lighthouses and other navigation lights, or 25 per cent., are electrified. The strongest is that at Kullen, in the Sound, with a light-power of three million Hefner candle-power. Practically all remaining sailing channel lights with wick lamps have been converted into AGA beacons. Of the 27 radio beacons which the Swedish Pilot Board has planned to erect, 17 are completed, seven of them being installed in light-vessels.

In the lecture it was pointed out that, in future, new methods of founding lighthouses on the sea floor would probably be adopted and that these (unattended by crews) would replace floating lights.

Port of New York Approaches

Deepening of the Ambrose Channel

The Ambrose Channel, the best and most direct of the approach channels to the Port of New York, has been undergoing since August last a course of dredging with the object of providing a minimum depth of 45 feet, and, according to American press reports, the work is at the point of completion, and probably by now completed. It has been carried out by the United States Army Corps of Engineers.

The enlargement of the middle section of the channel, which has involved the removal of 3,300,000 cubic yards of sand and silt from an area 13 miles long and 800 feet wide, will, it is stated, enable the largest ships afloat—the *Lafayette* (ex *Normandie*), *Queen Elizabeth* and *Queen Mary*, in particular—to enter and leave port with greater facility than was previously permitted by the 40-ft. depth of Ambrose Channel, and will make the waterway readily usable by heavy capital ships damaged at sea.

The project was conceived as a means of speeding up the port entries and departures of the big passenger liners when speed, then a major consideration, was sometimes impaired by the necessity for caution in navigating the channel. The unusually heavy loading of large ships since the war began has made the deepening all the more desirable. Heavy naval craft, if damaged, could not use the channel at its 40-ft. depth because of their deeper draught in a damaged condition. A large capital ship in a damaged condition might have to remain exposed in the open sea until temporary repairs could be made to reduce the draught.

Army engineers have used on the work their sea-going hopper dredger *Goethals*—the largest dredger of her kind in the world—and a smaller ship, the *Navesink*. The dredger *Goethals* resembles a twin-screw bulk cargo ship and displaces 15,000 tons when fully loaded. In place of cargo holds she is equipped with hoppers into which dredged material is pumped. There are 16 screw-operated bottom gates in the hoppers through which sand and silt are emptied at the dumping sites. Seagoing hopper dredgers of the Corps of Engineers have been used extensively in other operations in the New York and New Jersey Channels, in the Bay Ridge, Red Hook, Buttermilk, Hudson River and Anchorage Channels and the Red Hook Flats anchorage.

Port of London Authority Staff War Distinctions.

Since the outbreak of war and up to the end of February this year, 183 British and Foreign Honours and Awards were earned by members of the Port of London Authority's staff. The following list includes military and civilian awards, viz:—

Officer of the Order of the British Empire (O.B.E.)	5
Member of the Order of the British Empire (M.B.E.)	11
George Medal	23
Distinguished Service Cross	2
British Empire Medal	25
Mentioned in Despatches	14
Commended for bravery in Civil Defence	99
Foreign Decorations	4
	183

The number of members of the staff at present serving in the Forces—including the Merchant Navy as well as the three Services—is 1,161.

It has to be recorded, with great regret, that war casualties among the Authority's staff include 97 deaths while on active service in the Forces and 59 through enemy air raids.

The National Dock Labour Corporation, Ltd.

Reduction in Percentage Payments

The following Notice has been issued to Port Transport Employers by the National Dock Labour Corporation.

1. The Directors of the Corporation, with the approval of the Minister of Labour and National Service, have decided that the rates of percentage payments as from and including Pay Week No. 18—(i.e., commencing after normal finishing time on Saturday, 29th April, 1944)—and until otherwise determined, shall be:

(a) **in respect of Allocated Workers,**
a percentage payment of 10 (ten) per cent. on their gross wages, including overtime and allowances.

(b) **in respect of Weekly Port Transport Workers,**
a percentage payment of 6¼ (six and one-quarter) per cent. on their gross wages, including overtime and allowances—the employer bearing the cost of his contributions under State Insurance Schemes.

2. The Directors' decision and the Minister's approval thereto are subject to an immediate review of the position at any time should a change in circumstances warrant this course.

New Chairman Appointed

Sir Ronald Garrett having asked to be relieved of his post as Chairman of the Corporation owing to increasing pressure of other duties, the Minister of Labour and National Service has appointed Lord Ammon to the position.

Australian Port Expansion

Increased Berthage Accommodation

The *Adelaide Advertiser* of December 18th, which has recently come to hand, contains a lengthy article recounting the activities of the Allied Works Council in Australia, including the provision of additional berthage accommodation at the ports of Darwin, Cairns, Townsville, Brisbane, Sydney, Melbourne and Fremantle.

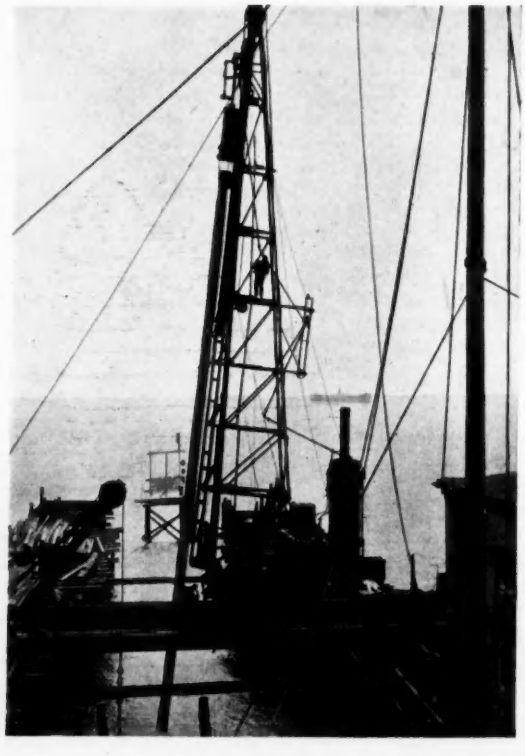
An Unlocated New Port

One huge maritime project under way is the building of a transhipment port for the U.S. forces at a cost of £3,500,000.

The chief works involved are the dredging of about 3,000,000 cubic yards of solid material from a harbour; the building of 6,000 feet of wharfage, to be divided into 12 sections, each 500 feet in length; the erection of 12 transhipment sheds adjacent to the wharfs, each shed 400 feet by 100 feet; the erection on a site removed from the wharfs of another 83 warehouses and storerooms, similar to the transhipment sheds; the construction of two concrete access roads, each about three miles long; the building of about 15 miles of subsidiary roads to link the wharfs with the network of stores and warehouses; and the laying of about 10 miles of railway line to connect the wharfs with the rail transhipment sheds.

In all, about 4,000,000 square feet of concrete floor space will be provided for the handling and storage of cargoes.

Apart from the construction of the stores and warehouses, housing and office accommodation will be provided for the 12,000 men who will work in the centre on its completion.



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